Journal of Chemical Education

Published by
Division of Chemical Education of The American Chemical Society
Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924

Vol. III **April, 1926** **No. 4**

CONTENTS

	Page
Frontispiece	opposite 369
Editor's Outlook	369
On the Numerical Data of Dispersoidology. P. P. von Weimarn	373
Bromine and Its Discoverers, 1826–1926. Edgar F. Smith	382
Catalytic Synthesis at High Pressures. J. A. Almquist	385
Sugar from Beets. A. R. Nees	390
Pandemic Chemistry. Wilder D. Bancroft	396
Research on Electrodeposition at the Bureau of Standards. William Blum	401
The Value of Inspection Trips as an Adjunct in the Teaching of Applied Chemical Principles. D. S. Chamberlin and M. K. Buckley	405
Printing Ink. W. F. Harrison	408
Simplified Calculations in Colorimetry. Robt. F. McCrackan, *et al.*	416
Note-Books in Laboratory Instruction. W. G. Bowers	419
Applications of Modern Valence Theories to Some Inorganic Chemical Reactions. M. A. Griggs and M. E. Warner	425
Lacquers as Protective Coatings. Arthur Orr	432
How Many Colloids Have You Used Today? V. N. Morris	438
A Simple Apparatus for Demonstration of Cataphoresis. R. E. Greenfield and A. L. Elder	443
Mental Processes Required in Examinations in Chemistry. Stephen G. Rich	445
Demonstrating Chemical Equilibrium. Norris W. Rakestraw	450
Correspondence	452
Chemical Digest:	
Editorial Paragraphs	455
An Educational Project of the Seventeenth Century	457
Abstracts of Papers Delivered at the Tulsa Meeting	459
Abstracts	465

Industrial Alcohol; Market Reactions to Research; The Future of Chemical Fibers; The Expansion of Vanillin Consumption; Why Inventions Play a Vital Part in Investment Values; Freezing Points; Elimination of Salt from Sea-Water Ice; The Senate of Chemical Education; "Nomag" Non-Magnetic Cast Iron; Letter to High-School Teacher from Former College Professor; Oil and Gas as Domestic Fuel; Chemical Program at Conference of Institute of Politics, Williamstown, Mass.; Kaolin Discovered in Vermont; Pigment Colors vs. Coal Tar Dyes; Wall-Paper Has Lengthy History; X-Ray Analysis of Organic Compounds; Passivity, Catalytic Action, and Other Phenomena; X-Rays in Industry; The Transmutation of Elements; The Art of Examination; Transmutation of Elements; The Occurrence of Dwi-Manganese (At. No. 75) in Manganese Salts; Science Tests: The New Type versus the Old Type; How to Get a Closer Relationship between the Chemistry of High School and College; Artificial Silk; The Scientific Background of Baking; New Norms for Iowa Placement Tests; On the Separation of Crystalloids from One Another by Dialysis; The Solubility of Hydrogen in Tin and Aluminium at High Temperatures; Models of Electron Structure, Quantum Action, and the Gravitational Field; Visual Education in an Industrial School; From Slave to Scientist; Thirty-Second Annual Report of the Committee on Atomic Weights; Determinations Published during 1925; The Atomic Weight of Uranium Lead and the Age of an Especially Ancient Uranitite; The Use of Subscript and Superscript Exponents in Chemistry; Keeping Pace with the Advancing Curriculum; The New Teacher; Teach Them How to Save Their Sight; On the δ-Rays Produced by α Particles in Different Gases; Why Colleges?; Teach the Engineer to Write.

Local Activities and Opportunities	472
Recent Books	475
Go to Summer School!	477
Every Month	478

BOSTON UNIVERSITY
COLLEGE OF LIBERAL ARTS
LIBRARY

UNITED STATES CIVIL SERVICE EXAMINATION FOR JUNIOR PHYSICIST

Receipt of applications for junior physicist will close May 1st. The date for assembling of competitors will be stated on the admission cards sent applicants after the close of receipt of applications.

The examination is to fill vacancies in the Bureau of Standards, Department of Commerce, and in positions requiring similar qualifications.

The entrance salary for this position in the District of Columbia is $1860 a year. After the probational period required by the civil service act and rules, advancement in pay, without material change in duties, may be made to higher rates within the pay range for the grade, up to a maximum of $2400 a year. Promotion to higher grades may be made in accordance with the civil service rules as vacancies occur. For appointment to the Field Service the salary will be approximately the same.

Examination will be given in the optional subjects of electricity, heat, mechanics, optics, physical metallurgy, and radio.

Competitors will be rated on general physics, mathematics through calculus, and practical questions on each optional subject chosen.

The work of the Bureau of Standards includes many branches of physics, chemistry, and engineering, such as mechanics, heat, optics, electricity, sound, metrology, metallurgy, radio, electronics, engineering (gas, electrical, mechanical, etc.), also industrial technology, including research and standardization, and offers valuable experience in these professions, combining as it does theoretical, experimental, and practical work. The duties of junior physicist will be in connection with original investigations in some field of the Bureau's work. The chances for advancement are good for those who prove capable.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the postoffice or customhouse in any city.

UNITED STATES CIVIL SERVICE EXAMINATION FOR MINOR LABORATORY APPRENTICE

Receipt of applicants for minor laboratory apprentice will close May 15. The date for assembling of competitors will be stated on the admission cards sent applicants after the close of receipt of applications.

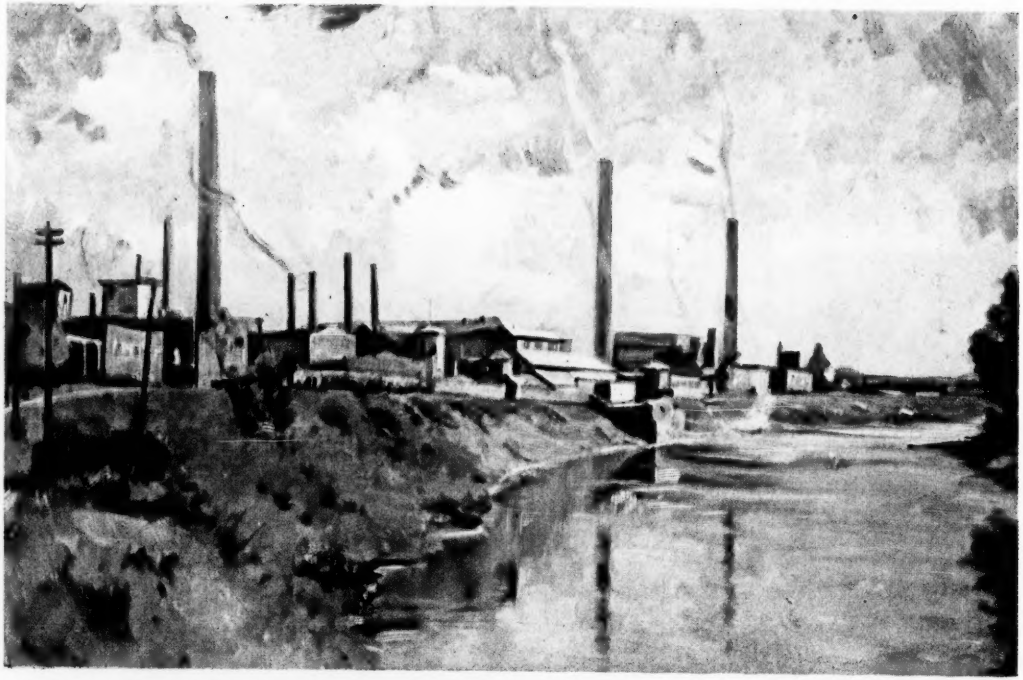
The examination is to fill vacancies in the Bureau of Standards, Department of Commerce, and other branches of the Departmental Service, and vacancies in positions requiring similar qualifications, throughout the United States.

The entrance salary in the District of Columbia is $900 a year. After the probational period required by the civil service act and rules, advancement in pay without material change in duties, may be made to higher rates within the pay range for the grade, up to a maximum of $1260 a year. Promotion to higher grades may be made in accordance with the civil service rules as vacancies occur.

Competitors will be rated on elementary algebra and geometry, elementary physics or chemistry, mechanical drawing to be handed to the examiner on the day of the examination, and education and experience.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or customhouse in any city.

BOSTON UNIVERSITY
COLLEGE OF LIBERAL ARTS
LIBRARY



River Front View of The Dow Chemical Company's Works at Midland, Michigan—*By A. H. K. Hammond*

EDITOR'S OUTLOOK

The Frontispiece

FOR this month's frontispiece we are indebted to the Dow Chemical Company of Midland, Michigan. The original is one of a series of twenty-six paintings by an English artist, A. H. K. Hammond, depicting chemical operations and portions of the Dow works. We also wish to express our appreciation of the kindness of the Dow Chemical Company in permitting us the use of their color plates.

The Inarticulate Scientist

IN THE February number of *The Wiley Bulletin*, Prof. H. H. Higbee of the University of Michigan advances a plea for the development of writing ability among technical students, under the title, "Teach the Engineer to Write." Although he limits his discussion to engineers, it is equally applicable to chemists, as the following quotation will indicate.

> In consideration of the important, useful and potentially interesting things they know, it is astounding how few engineers are able to express themselves appealingly either in writing or speech, even to other engineers who speak their jargon, far less to the public which is shamefully unappreciative of their abilities and worth, while enormously indebted for their achievement. There will never be an end to this situation until we not only require our students to write whenever a good motif is found, but make it commendable for them to do so. It avails little for a teacher in a professional department to sanction the student's taking a writing course in the department of English if he does not also say through his own actions that it is quite as important for an engineer to make occasion for writing good, interesting, non-technical English as it is to make occasion for calculations and drawings and for writing technical specifications.

It is readily conceded that scientific students should be taught to record the results of researches and to prepare technical reports in clear-cut scientific language. Scientists, generally, are even awakening to the desirability of informing the public in non-technical language of the work which they are doing. There seems to be a wide-spread belief, however, that this latter undertaking is properly the function of a new school of specialists—the popularizers of science. It is looked upon as a branch of journalism—a highly specialized branch and one which calls for thorough scientific training, yet definitely journalistic in nature rather than scientific.

Too many instructors, as Prof. Higbee points out, manage to convey to their students (by implication if not by precept) the impression that it is the business of the scientist to "saw wood" and leave the presumably lesser occupation of talking about it to others. Indeed, the ignorant superstition that fluency of expression is incompatible with sound knowl-

edge flourishes in quarters where one would expect to encounter greater enlightenment. The fact that so many men of real scientific ability are so woefully incapable of expressing themselves gracefully or even passably seems to be accepted as proof that illiteracy is one of the prerequisites to scientific attainment. One is almost led to suspect the operation of a "defense mechanism" in this connection.

The student notes that glaring errors in spelling and punctuation and gross improprieties in grammar escape censure in his examinations and technical themes so long as he does not misstate bare facts. He observes the linguistic gaucherie of men whose scientific work he respects and he hears the man who writes entertainingly and at great length about nothing at all justly disparaged. Is it any wonder that he soon adopts the idea that expression is a matter of trivial importance?

H. G. Wells contends that in this age no man has so much that is well worth saying as the scientist and he adds that no man is less qualified to say it. If this be true, there is hope. Surely it is easier to teach the man who has something to say how to say it than it is to supply the fluent jack-ass with ideas. The world is agreed that the scientist has been the outstanding material benefactor to humanity. How seldom, however, has the scientist contrived to share with his fellows the intellectual joys of search and discovery which are the mainsprings of his work. Is it too much to hope that there will be more scientific books, even in chemistry, which will compare with Darwin's *Origin of Species* or, better still, Jean Henri Fabre's *Life of the Caterpillar?*

Poetry *alias* Promotion

PHI Beta Kappa announces the launching of a nation-wide campaign to raise a sesquicentennial fund of one million dollars to aid in "restoring scholarship and teaching to their rightful place." The spirit of this endeavor cannot fail of the approval of all lovers of learning. Granted that scholarship may be satisfactorily defined and accurately evaluated, it still remains a question, however, whether or not the genuine article can be induced by the offer of material reward or by any other consideration than an innate love of scholarship for its own sake.

True, our churches and our legislatures have long combined to encourage a fair counterfeit of virtue by proclaiming that good conduct shall be rewarded and evil conduct penalized, probably here, but certainly hereafter. Be it said in passing that no adverse criticism is implied. For all practical social purposes the semblance of virtue answers quite as well as actual righteousness. The thief at heart who refrains from thievery through fear of hell-fire and the police is no more a menace

to his neighbor's property than the innately honest man. Perhaps some such semblance of scholarship as may be induced by the hope of reward will prove equally satisfactory. We take the liberty of doubting.

There is, of course, a fine poetic justice in adding unto a man some of those things which he has had to forego in pursuing scholarship. Would that there were more fairy god-mothers to undertake the task. We should not, however, too readily persuade ourselves that scholarship is to be "promoted" in this fashion.

Chemical Engineering Education Conference

THE conference on chemical engineering education, under the auspices of the American Institute of Chemical Engineers, met on Friday, March 26th, at Columbia University. The keen interest called forth was amply evidenced by the large number in attendance, the distances from which many of them came and the fact that discussions continued with animation until a comparatively late hour in the day.

Dr. Arthur D. Little opened the conference with a paper on "Chemical Engineering—What It Is and What It Is Not," in which he defined the field which is clearly the province of the chemical engineer.

Prof. W. L. Badger of the University of Michigan followed with a discussion of "The Curriculum." The multiplicity of subjects listed and the variations in nomenclature employed make it a difficult task, he pointed out, to prepare a truly accurate survey of existent curricula. He did submit, however, an outline of percentages of course time devoted to each of nine general groups of subjects in various institutions. Much of the confusion which exists is due to varying local conditions and there is no practical solution in sight.

More rigid selection of chemical engineering students, both at entrance to the course and before progressing to the advanced or professional stages, is desirable, according to Prof. J. H. James of the Carnegie Institute of Technology who spoke on "Entrance Requirements." He emphasized the importance of considering the personality and temperament of the student as well as his previous preparation and scholastic performance.

Prof. D. D. Jackson of Columbia and Prof. J. R. Withrow of Ohio State agreed that four-, five-, and six-year courses all have a rightful and necessary place in the scheme of chemical engineering education. It should be clearly understood, however, that a four-year course does not fit a student to do the same kind of work as a six- or a seven-year course.

The question whether chemical engineering should constitute a sepa-

rate department in the College of Engineering or a subordinate course in the Department of Chemistry, should be determined largely by local conditions. Prof. H. A. Curtis of Yale and Prof. S. W. Parr of the University of Illinois, who discussed "Local Administration," believe, however, that in either case the course should be fundamentally chemical.

Concerning "Qualifications of Faculty," Prof. W. K. Lewis of the Massachusetts Institute of Technology laid emphasis on the fact that only the highest type of men should be considered for faculty personnel. Prof. A. W. Hixson of Columbia, in speaking of "The Chemical Engineering Laboratory," declared that students should be given every encouragement to exercise initiative in their work. They should, he said, be permitted to employ their own methods except when those methods are plainly wrong.

An open discussion of the Institute's plan of approving courses concluded the meeting.

Humanizing Chemistry

IT SEEMS highly probable that we shall eventually be forced to acknowledge that no one course or type of course in college chemistry can satisfactorily fulfil the dual function of introducing the technical student to a thorough study of chemistry and furnishing the non-technical student with a cultural knowledge of the subject. Dr. Bancroft's outline on Pandemic Chemistry, in this issue, is a tentative effort towards the formulation of an avowedly cultural course. In his own words it aims to teach the student a little chemistry and quite a bit *about* chemistry.

At this point we are confronted with the problem which perpetually torments the humanizer of science. Just how much *science* must we teach a pupil before we can effectively teach him much *about* science? It is indeed hard for the trained chemist to survey the conventional course in freshman chemistry and say that any part of the material which has been condensed into it is non-essential. On the other hand he must remember that it is his function, so far as non-technical students are concerned, to turn out pupils with a cultural knowledge of chemistry—not chemists in an arrested stage of development.

Clearly the task is one which demands judgment and pedagogic talent of the highest type. Nor will anything short of a profound knowledge of chemistry qualify an instructor to undertake such a course. It requires training to treat a subject comprehensively, but little short of genius is necessary to select and condense.

We would like to see a number of universities offer such a course and are convinced that much good would come of it, provided these facts are kept in mind.

ON THE NUMERICAL DATA OF DISPERSOIDOLOGY*

P. P. VON WEIMARN, HEAD OF THE DISPERSOIDOLOGICAL DEPARTMENT OF THE IMPERIAL INDUSTRIAL RESEARCH INSTITUTE OF OSAKA, JAPAN

Introductory

Introductory
The Influence of the Comparatively Early Age of Dispersoidology on the Character of Its Numerical Data
The Difficulty of Obtaining Exact Numerical Data for Dispersoidological Magnitudes, Arising from the Dependence of These Magnitudes on a Large Number of Variables
The Difficulty of Obtaining Easily Reproducible Numerical Data, as Conditioned by the Constant Mutability in Time of the Properties of Disperse Systems
Conclusion

That it is difficult to re-obtain a disperse system exhibiting properties expressed, upon reproduction, by the same numerical data as before, *i. e.*, that not infrequently the numerical data on dispersoidology happen to be somewhat lacking in exactitude and are difficultly reproducible, is a belief which may be said to be most widely spread. Infinitely less widely spread is the understanding of the reasons to which the above features of the dispersoidological numerical data are due. It is with the object of briefly elucidating the nature of these reasons that the present paper has been written.

To begin with, it seems advantageous to distinguish between three groups of such reasons. The first group of reasons are conditioned by the fact that dispersoidology is comparatively a young science; the reasons classed with the second group arise in connection with the dependence of many dispersoidological magnitudes on a large (sometimes very large) number of variables; and the reasons of the third group are due to the disperse systems being *subject to constant changes* in the course of time.

The *first* group of reasons holds good for any scientific discipline in its early period of existence. The *second* group of reasons exists, of course, for any kind of magnitudes, and *not for the dispersoidological magnitudes alone*, whenever these magnitudes are dependent upon a large number of variables. But, of course, dispersoidology is much richer in that kind of magnitudes than is any other section of physical chemistry which has so-far evolved from the mother-science, *e. g.*, than electrochemistry or thermochemistry. Nor is the *third* group of reasons peculiar to the formations dealt with in dispersoidology, being common, in a general way, to *all kinds of unstable formations*. But it deserves being stressed, even

* *Author's Note.*—In the "Editor's Outlook" published in THIS JOURNAL, **2**, 518 (1925), the teachers of chemistry are invited, in terms that altogether correspond to the actual state of things, to pay attention to the importance which at our time undoubtedly belongs to the science of colloids or *Dispersoidology*. The present author, who, to the best of his ability, has been working, for more than twenty years already in the field of dispersoidology, ventures to hope that the present paper also will be of some interest and prove serviceable to the teachers of chemistry.

in this introduction, that dispersoidology is preëminently a science swarming with systems present in an unstable condition and subject to constant changes.

The Influence of the Comparatively Early Age of Dispersoidology on the Character of Its Numerical Data

Although the term "colloid" had been introduced into the domain of natural science by the great English scientist, Thomas Graham, as early as in 1861, that is to say, 65 years ago, the time elapsed since the colloids have become the object of a really intensive study does not yet cover a period of twenty-five years.

One has to consider that even ultramicroscopy was invented only in 1903; and only commencing with the years 1906-1907 may we regard it as an accomplished fact that the comparatively narrow doctrine of the colloids has definitely evolved into an extremely comprehensive science—both in regard to its compass, and to the broad perspectives it lays open—the science called *Dispersoidology*.[1]

It is just in connection with the early age of dispersoidology that the *first* group of reasons arises to account for the fact that, in a considerable number of cases, the dispersoidological numerical data (which, by the way, are rather numerous than otherwise) are not so very exact, or have been obtained under not altogether strictly defined conditions.

In the early period—the period of *intensive development*—of any science, those among the investigators who perceive clearly the most rational ways leading to a speedy advancement of the science they are called upon to develop, will devote their efforts in the first place to the task of determining the role that belongs to each of the *variables* governing the phenomena, to the task of finding, in the shortest possible time, those *general*, leading principles, those *basic laws*, which hold sway over the domain of the newly created scientific discipline.

And not until this initial stage of *intensive development* has come to an end, is it of any advantage to proceed to any "rigorously exact" quantitative investigations. Applying "rigorously exact" quantitative methods in any science whatever while the initial period of its intensive development still lasts, is just as little advantageous, and economically just as wasteful as would be tracing out railroads in a newly discovered country, without previously exploring that country, and without at first covering it with a system of ordinary walks and rides. So long as that period in the development of the science still lasts, it is enough to apply such quan-

[1] Wolfgang Ostwald: "History of Colloidal Chemistry," in the first edition (1909) of "Grundriss der Kolloidchemie," Verlag von T. Steinkopff, Dresden, pp. 1–76. P. P. von Weimarn: "Some Data of the History of Dispersoidology," in the book, "Die Allgemeinheit des Kolloidzustandes," Verlag von T. Steinkopff, pp. 385–504, 1925.

titative methods as are not rigorously, but only *approximately* exact. Such methods are sometimes called *qualitative*, which, however, is logically a most ill-adapted term.

Let us adduce an instance. In order to establish one of the general laws governing precipitation,[2] namely the law which reads: whenever certain conditions are observed, the mean magnitude of the individual precipitate crystals will decrease as the concentration of the reacting solutions increases, no more was needed than to prove that, with progressively increasing concentration of the reacting solutions, the values (at $b, c, d, e, f \ldots$) for the mean magnitudes of the crystals will actually fit into the inequality: $a > b > c > d > e > f > \ldots\ldots\ldots (A)$.

It is altogether obvious that the *degree of universality*—and its corollary—the *degree of scientific importance*—of a law of that kind depend upon the *number of different, independent instances* by which the existence of inequalities of the type (A) has been proved, and by no means any especially high degree of accuracy in the measurement of the magnitudes: $a, b, c, d, e, f, \ldots\ldots$ For the sake of establishing inequalities of the type (A), it is enough to carry out comparatively roughly approximated measurements of the dimensions of crystals in precipitates obtained on applying progressively increasing concentrations, of the reacting solutions.

Another circumstance, which renders altogether unacceptable a certain number of numerical data encountered in the dispersoidological literature, is of an entirely different nature and lies with the lack of understanding, on the part of some experimentalists, that, in a given science, the exact quantitative investigations can only prove fecund if the analysis of the principal variables influencing the course of phenomena has already been accomplished—if the most important of the fundamental laws and principles swaying the domain of that science have been firmly established.

But it always happens that, even in the infancy stage of the development of any new science, this science never lacks, among its investigators, some such people as make a special point of executing "strictly quantitative" measurements, of calculating all kinds of "numbers." No wonder if, in the course of further development of that science, these "strictly quantitative" measurements prove, in large part, to be of no value at all. So long as no analysis of the principal variables has yet been made, one is likely to commit even so big a blunder as devoting one's efforts to the measurement of something that is not at all the thing one intended to measure.

And such kinds of "would-be-accurate" numerical data are by no means few in dispersoidology; enough, for instance, to mention the so-

[2] For particulars see P. P. von Weimarn, "The Precipitation Laws," *Chem. Rev.*, **2**, 217–42 (1925).

called numbers for the "molecular weights" of many colloids. In this connection it is well to quote R. Luther[3] who says:

> While the measurement of some prescribed magnitude may be effected, at a given epoch, and by a given method, with a degree of preciseness that is almost unlimited, the result—in spite of all the time spent, and all the artfulness displayed—may still be very far from the truth.

As we know, there exist most excellent methods of accurate measurement of the molecular weights of substances when present in a true solution, but the application of these methods to dispersoidal solutions of substances practically incapable of dissolving truly (as nowadays is clear to every dispersoidologist) cannot furnish numerical data that might be regarded as a correct expression of the "molecular weights" of such substances.

The Difficulty of Obtaining Exact Numerical Data for Dispersoidological Magnitudes, Arising from the Dependence of These Magnitudes on a Large Number of Variables

The second group of reasons which, most especially in dispersoidology, make the preparation of really exact and easily reproducible numerical data extremely difficult consists in the dispersoidological magnitudes being for the most part dependent simultaneously on a very large number of variables. Nothing that would even nearly approach that state of things has ever been known to exist in any other scientific discipline. If anything stands any comparison with this, it is the domain of the supersaturated and the undercooled systems. But then, one should not forget that these are systems, of which a certain part at least are closely related to a certain class of dispersoidal solutions.[4]

In order to show clearly, how large a number of variables will influence the values of the kind of dispersoidological magnitudes here under discussion, one single instance will suffice. Let us consider, *e. g.*, upon what variables—*assuming practically constant concentration of disperse phase, practically constant temperature and pressure*—the "duration of life" of dispersoidal solution depends—say that of a dispersoidal solution of sulfur in an aqueous medium. Whichever way we choose—whether we submit the processes taking place in the course of time, to a theoretical analysis[5] or whether we proceed by way of direct experimenting—we shall arrive at the same conclusions, notably that the "duration of life" of our dispersoidal solution depends on: (1) The average dimensions of

[3] Ostwald-Luther, "Hand- und Hülfsbuch zur Ausführung physiko-chemischer Messungen," 3 Auflage, p. 14, **1910.**

[4] P. P. von Weimarn, "Grundzuege der Dispersoidchemie," Verlag von T. Steinkopff, Dresden, p. 80, **1911.**

[5] For details see P. P. von Weimarn, *Koll.-Zeitschr.*, **37,** 151 (1925).

the *individual* particles of disperse phase; (2) The distribution (percentage distribution) of individual particles of *different* dimensions throughout the disperse phase; (3) The ratio of the number of *aggregated* particles to the number of *individual* particles in the disperse phase under examination; (4) The *degree of fastness* with which the individual particles are held together in coadjacence (or concrescence—as a special case) in the aggregated particles; and, in addition to these four variables, on a very large number, "n", of other variables determining the dependence of the "duration of life" of a dispersoidal solution on the concentration and the chemical nature of the so-called "foreign" substances which are present in the dispersion medium (and in the disperse phase) in either the condition of true or of dispersoidal solution.

Supposing that we confine ourselves to taking into account only the electrolytes truly dissolved in the dispersion medium—even in that case the number "n" is likely to be greater than 10. And if now we consider that the concentration of disperse phase in a dispersoidal solution is often equal to but a few centigrams (sometimes a few milligrams) per liter of the dispersion medium, and if we pay due regard to the fact that not infrequently the electrolytes will most substantially affect the duration of life of a dispersoidal solution, even when present in concentrations of thousandth parts of a millimol per liter, their effects being, at that, dependent on both the concentration[6] and the chemical nature of these electrolytes—we shall be left with no misapprehensions concerning the fact that, in dispersoidological research work which is expected to be *rigorously exact*, and whenever aiming at results that will really be *quantitatively exactly* reproducible, the grade of *purity* of the reagents applied, and the grade of scrupulous cleanliness to be observed in working must be immensely superior to those usually recognized as satisfactory for carrying out the most delicate, the most rigorously exact quantitative research work in any other branch of physical chemistry.

The less the concentration of disperse phase in a dispersoidal solution, the purer must be the reacting solutions applied, and the more scrupulously tidy the execution of any manipulations involved in the research work—whenever one pursues the task to arrive at a quantitative reproducibility of the results.

If we designate by the symbol "C_k" the concentration of disperse phase in the dispersoidal solution under examination, and by the symbol "C_r" the varying concentration of the admixtures, about which the investigator knows nothing (and which consequently escape consideration), present in the reagents and the dispersion medium, then the value of the ratio,

$$n = \frac{C_r}{C_k},$$

[6] P. P. von Weimarn and S. Utzino, *Koll.-Zeitschr.*, **36**, 265 (1925).

will be the non-reproducibility-coefficient of the given disperse system. If this coefficient is zero—that is to say, if everything connected with the work has been *absolutely* pure and clean ($C_r = 0$)—there will be no such thing as non-reproducibility. If, on the other hand, the value of "C_r" is considerable, in comparison with the value of "C_k" then the experiment will be difficultly reproducible, and the more difficultly the greater the values of "n", and the less constant these values are. It is not difficult to understand that, if C_k is extremely small, then, wholly in agreement with the law of mass action, even vanishingly small amounts of admixtures (as estimated according to the usual standards)—will most strongly affect the quantitative results of the experiments.

Many dispersoidologists were, of course, well aware of the existence of the group of reasons just discussed which, along with other kinds of reasons, are responsible for the comparatively low degree of accuracy and the difficult reproducibility of the dispersoidological numerical data. On the other hand, however, these dispersoidologists could not but recognize that the most natural tendency of the young science to have its principal variables submitted to a critical analysis, and its most general laws established, had to be satisfied in the first place; and so, any kind of especially exact, purely mensural dispersoidological research work, for which time and patience are the chief requisites, has been postponed in execution until later times.

The Difficulty of Obtaining Easily Reproducible Numerical Data as Conditioned by the Constant Mutability in Time of the Properties of Disperse Systems

The third group of reasons to which the comparatively incomplete exactitude and the difficult reproducibility of the numerical data of dispersoidology are due, arise in connection with the fact that the disperse systems happen to be present in a condition of constant changes taking place in the course of time. One is, therefore, fully justified in speaking of such systems as being "alive," and in accepting that also the numerical data relating to the one or to the other measurable property of these systems will change, dependent on the age and the antecedents of a given system. It is quite obvious that whenever one undertakes re-obtaining some definite set of numerical data, while being completely in the dark as to the "age" and other "antecedents" of the corresponding disperse system, it is only by mere chance that the same data as before may be obtained again. And cases are by no means rare, when the *age* and the *history of previous life* of a set of disperse systems are entirely unknown to us. Under such circumstances one can do no more than to establish some kinds of "series of inequalities" or simply "series" which will show

that there is one substance affecting the disperse system in a stronger measure than do other substances.

So, for instance, the average rates at which a certain *given* kind of cellulose, on applying a certain *given* method of work, is capable of being dispergated into dispersoidal solution by means of hot aqueous concentrated solutions of the thiocyanates of Ca, Sr, and Ba, are expressed by wholly well-defined numbers: *e. g.*, $a_{Ca(CNS)_2}$, $b_{Sr(CNS)_2}$, $c_{Ba(CNS)_2}$, which happen to fit into the inequality:

$$a_{Ca(CNS)_2} > b_{Sr(CNS)_2} > c_{Ba(CNS)_2}$$

If, now, we take some *other* kind of cellulose, then, although strictly observing the same method of work as before, the numbers obtained for the above rates will be some quite different ones; but, nevertheless, the sense of the new inequality:

$$a_{Ca(CNS)_2} > b_{Sr(CNS)_2} > c_{Ba(CNS)_2}$$

will remain exactly the same as before. And however strongly the numerical data may differ from those previously obtained, the same inequality holds for a large number of other kinds of cellulose.

Although it is impossible, in the instance just quoted, to express the various abilities of the thiocyanate solutions to produce dispergation (these are magnitudes directly dependent on the rates of dispergation) by single numbers that would hold for all the different kinds of cellulose, it is still possible to arrange these dispergation abilities of thiocyanates as members of the following general series of inequalities:

$$D_{Ca(CNS)_2} > D_{Sr(CNS)_2} > D_{Ba(CNS)_2}$$[7]

Whoever has made a study of dispersoidology knows well that quite a number of properties of disperse systems used to be expressed by similar kinds of series.

Most certainly, if the "age" and the "history of life" of a given set of disperse systems are known—which is tantamount to saying that the whole number of variables affecting the magnitudes to be measured are known—the numerical data one obtains will be susceptible of reproduction with greater or lesser difficulty, at any time, and that kind of dispersoidological numerical data will be inferior no longer, in the sense of exactitude, to similar kinds of data in other scientific disciplines.

Conclusion

In the preceding pages the reasons have briefly been laid bare which condition the difficult reproducibility, or lacking accuracy, of some of

[7] For more details see P. P. von Weimarn, "Reports of the Imperial Industrial Research Institute of Osaka," **6**, p. 63 (1925). I wish to point out that the different dispergability of different kinds of cellulose represents an intricate function of its "age" and its "history of life."

the dispersoidological numerical data. A clear understanding of the reasons above treated is all-important for producing, in the course of further development of dispersoidology, such numerical data as will be of the *highest* possible grade of exactitude, and of the *easiest* possible reproducibility. But anyhow, there must be no blinking the fact that the task is obviously hopeless, to render numerical data pertaining to magnitudes that depend on, say, ten different variables just as easily reproducible as are the numerical data for a magnitude depending on one or on two variables only. It goes without saying, that on drawing that parallel that the whole set of remaining conditions is assumed to be equal in both cases.

To no lesser extent is it obvious that much greater efforts are needed, in order to arrive at the same degree of accuracy of the data, when measuring magnitudes that are dependent upon ten different variables—other conditions being equal—than one has to spend in measuring magnitudes dependent on one or on a couple of variables. A thorough understanding of the above considerations is most important.

In any scientific discipline—consequently also in dispersoidology—one may always distinguish between two types of scientists, representatives of two extremes (which, of course, are connected with each other by transition or intermediary types): (1) The scientist-thinkers, and (2) the scientist-measurers.

The scientist belonging to either of these two types will then, and then only, contribute to the building up of science, when the ideas of those of the first category are susceptible of experimental test, be it only in principle (*i. e.*, if not now, then in the future); and when the scientists of the second category will not proceed to carrying out their accurate measurements until a mental analysis of the variables influencing the magnitude to be measured has been made by either themselves or by other people. But if the ideas of the "scientist-thinker" are of a nature that does not admit, even in principle (*i. e.*, not even in the very distant future), of any experimental test, such a scientist is nothing but a romancer, pure and simple, and if the "scientist-measurer" indulges in making "rigorously exact" measurements of magnitudes that have never been submitted to any mental analysis, he is scientist no longer, but only a "measuring-automaton."

No science could ever dispense with creative work of a speculative character, nor can dispersoidology do without it; and one cannot but heartily concur with Walter Nernst, when he says:[8]

> We may say then that the speculative activity of the investigator must be directed, not only to observation and measurement of phenomena, but to the discovery of the most general laws and the most useful hypotheses.

[8] W. Nernst, "Theoretical Chemistry," MacMillan Book Co., London, 1911, p. 3.

That the human mind has turned with predilection at all times, though in different degrees, to the elaboration of hypotheses, is to be ascribed to the circumstance that the mental satisfaction afforded in finding a new law of nature is greater when it is inferred deductively from universal generalizations, than when inferred inductively from knowledge tediously acquired.

And, therefore, it is not only with the development of methods of accurate measurement that the advancement and the success of dispersoidology lies, but also—and in some cases even to a much greater extent—with the discovery of new phenomena, with a conceptionally analytic treatment of all things known and all things newly observed; and by no means should the speculative activity of the investigators be regarded as an unnecessary thing, or even as a hindrance to real advance in dispersoidology.

Yale Acquires Oldest Scientific Journal. The ownership of *The American Journal of Science*, one of the oldest scientific publications in the country, has passed from the Silliman and Dana families, who have edited it for more than a century, to Yale University. Professor Edward S. Dana and Prof. Alan M. Bateman of Yale will continue as editors.

Founded at New Haven in 1818 by Benjamin Silliman the Elder, the journal is known over the world as one of the leading scientific journals of America.—*Science Service*

Bee and Silkworm Diseases May Be Fought with Oxygen. Diseases of bees, silkworms, fishes, and even plants, caused by the minute one-celled animals known as protozoa, may be banished by means of the common element oxygen applied under pressure, according to Dr. L. R. Cleveland of the Harvard University Medical School. Preparation of immunizing cultures against certain diseases, ridding stored nuts and grain of insects, and the study of the life relations between the protozoa in the bodies of the animals that thus harbor them, are other problems suggested whose solution may be sought by means of oxygen under pressure.

One of the most troublesome and expensive diseases of silkworms, Dr. Cleveland points out, is caused by a certain protozoan species. He has found in his earlier studies that infected insects can be placed in bottles of pure oxygen at moderately high pressures without harm to the insects but that after this treatment the protozoa are all dead. He, therefore, suggests this treatment for protozoan-plagued silkworm colonies and for bee "nuclei," consisting of a queen and a few workers, with which a hive is usually started when a choice bee strain is to be introduced.

After pointing out the possibility of obtaining protozoan-free plants and insects for the purpose of making a study of certain puzzling plant diseases, Dr. Cleveland brings his argument closer to man, stating: "It has been reported that flagellates producing a disease in plants may, after passage through an invertebrate (insect) and a vertebrate (lizard) host, acquire pathogenic properties for a mammal. Oxygenation will perhaps give us uninfected but susceptible hosts to work with, which will enable us to determine beyond question the possible method or methods of infection in nature."

Dr. Cleveland's earlier work on the effects of oxygen on protozoa and their insect hosts won him half of the annual prize of the American Association for the Advancement of Science at its meeting in Washington during the holiday week in 1924.—*Science Service*

BROMINE AND ITS DISCOVERERS—1826–1926

EDGAR F. SMITH, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA.

A bottle containing bromine was placed on my laboratory table this morning by a younger colleague. As I gazed upon the heavy reddish brown liquid it flashed upon my memory that, one hundred years ago (1826), this interesting and exceedingly valuable element was discovered by Antoine Jerome Balard (1802–1876), then twenty-four years old.

Balard's origin was exceedingly humble. Apparently his home was so devoid of worldly goods that a loving, devoted godmother charged herself with his education, which began at the local college (of Montpellier), where in due course the lad was made an assistant in the École de Pharmacie, from which institution he received a diploma in 1826. His principal studies were chemistry and botany, and while botanizing in 1824 near a salt marsh he observed a deposit of sodium sulfate, which during a cold night had crystallized in a pan containing mother liquors from common salt. Studying these liquors in the course of his experimentation Balard was struck with a peculiar coloration occasioned by certain reagents when introduced into them. Stubbornly pursuing this line of attack he had the good fortune to discover *bromine*. And thus it was that the name of the young chemist, 24 years of age, became associated with those of Scheele and Gay-Lussac. The latter was particularly jubilant over the discovery. It meant another trophy for French science. He took particular delight in exhibiting specimens of the new element to his classes, while the young discoverer gave himself completely to learning more of the new member of the chemical family, writing shortly thereafter a really classic memoir upon his observations.

The Royal Society awarded him its highest distinction, and in the University he was appointed in succession to posts in the College of Pharmacy, in the Collége Royal, and in the Faculty of Sciences.

It is interesting to learn that in his experimental work Balard gave preference to the simplest processes and to primitive apparatus, recalling with marked pleasure the great discoveries which had emanated from Scheele's humble resources. And with it all, this must be added, that Balard's experiments possessed precision. None of his discoveries were ever contested.

As was to be expected he succeeded in time to the chair of Thenard in the Faculté des Sciences in Paris, and finally to that of Pelouze at the Collége de France. Election to membership in the Academy came in 1844.

Musty volumes tell us that this very distinguished master in chemical science was "of a happy temperament, leading a plain, almost ascetic life, while indulgent and liberal to others." It is also gratifying to hear

that he—the man of vast achievement in chemistry—was deeply beloved and revered by all his associates because of his upright character, thorough goodness and modesty, combined with great warmth of heart and

generosity. It is said that Balard exhibited the deepest interest in young chemists with whom he worked most sympathetically. His name, it is comforting to realize, is indelibly inscribed on the pages of science.

In reviewing the isolation and discovery of *bromine* very respectful consideration must be accorded Carl Löwig (1803–1890), a pupil of the eminent Leopold Gmelin in Heidelberg, for on matriculating there in 1825 he attracted unusual attention from Gmelin because of a dark red liquid he had brought with him from Kreuznach, his home town. He had obtained it by treating the concentrates from certain springs near Kreuznach with chlorine, then extracting the colored material with ether, when on distilling off the latter the dark red, heavy liquid remained. It proved a complete mystery to Leopold Gmelin and to all his students including young Löwig, at this time but 22 years of age. At the suggestion of Gmelin, however, that larger quantities of the strange body be prepared, Löwig promptly addressed himself to this task and was so engaged when Balard's extensive communication appeared in the *Annales de Chemie et de Physique*, telling of the discovery of *bromine* in the mother liquor of sea water. Thus was Löwig's mystery clarified, as the reddish brown liquid from Kreuznach waters was in every particular identical with that obtained by Balard. Poor Löwig! we may say, but was he not, in his disappointment, in excellent company? For Liebig had missed the same element, and Wöhler a few years later bowed to Sefström on the recognition of vanadium.

However, whether discouraged or not, Löwig for several years busied himself with bromine and supplemented handsomely the work of Balard. He became preëminent in chemistry, doing excellent work, and in conjunction with his pupils brought to light many very interesting substances, among them tin ethyl, antimony ethyl, lead ethyl, antimony trimethyl, antimony tetramethyl, etc.

According to H. Landolt (he of physical constant fame), Löwig was a decidedly interesting person. Among other things he had taught six semesters at the University of Heidelberg, 40 semesters at Zurich, and 72 semesters at Breslau, making a total of 118 semesters, while it was his heart's desire to have taught 120 semesters (60 years) from which he was deprived by a sad accident that eventually terminated in his decease.

Löwig's sketch of Jeremiah Benjamin Richter is a most complete story of that remarkable man and his work.

Surely, in honoring Balard a modicum of praise may be accorded Löwig—co-discoverer of *bromine*, an element the importance and application of which are far reaching.

Spain Will Have Laboratories. The Rockefeller Foundation has given $200,000 to Spain for a physico-chemical institute. It is expected that this will serve as a nucleus for experimental scientific work in Spain whose laboratories are at present few and lacking in modern equipment.—*Science Service*

CATALYTIC SYNTHESIS AT HIGH PRESSURES

J. A. ALMQUIST, FIXED NITROGEN RESEARCH LABORATORY, WASHINGTON, D. C.

The development of the process for the synthesis of ammonia from its elements has frequently been referred to as one of the outstanding achievements of chemistry and chemical engineering. Although the great importance of this development as a contribution to the solution of our nitrogen problem is sufficient in itself to warrant this statement, it now promises to be of even greater significance as the key process which has opened up the new field of catalytic reactions at high pressures.

A glance at the historical development of ammonia synthesis will suffice to indicate the many trials passed through by this pioneering process and to reveal the growth of certain principles, the appreciation of which we now know to be essential to the success of high pressure catalytic syntheses in general. The many attempts during the nineteenth century to effect the catalytic formation of ammonia from its elements at atmospheric pressure and high temperatures yielded results of such uncertainty that a spirited controversy arose as to whether or not its synthesis was possible. This was not answered until 1905, when a study of the equilibrium between ammonia, hydrogen, and nitrogen revealed the conditions of temperature and pressure under which the formation of definite quantities of ammonia is thermodynamically possible. This was a most important step, since a knowledge of the equilibrium revealed the necessity of working at high pressures and left the way clear for the perfection of this technic and for the study of the catalyst problem.

The obvious result of the study of ammonia catalysts was, of course, the development of satisfactory catalysts for this particular reaction. It may not be so well-known, however, that these studies at the same time brought forth or emphasized many significant facts concerning catalysts in general. Outstanding among these are: first, that catalysts are specifically sensitive to the presence of certain substances, some of which inhibit their activity, while others enhance it; and second, that extremely small concentrations of certain impurities in the gaseous reactants are able to inhibit markedly or suppress entirely the catalyst's activity. Substances capable of enhancing the activity of catalysts are now known as promoters, and those which inhibit are called catalyst poisons, whether they be present in the catalyst material or in the gaseous reactants.

With these concepts in mind, it is not so difficult to understand why the early progress on ammonia synthesis and related reactions was so slow, compared to the rapid development which has occurred during the last few years.

Much interest has recently been aroused by the production, on a commercial scale, of synthetic methanol from hydrogen and carbon monoxide, and in the possibility of extending such production to higher alcohols,

motor fuels, and various compounds of hydrogen, carbon, and oxygen. From the standpoint of the necessary raw materials, the choice of hydrogen and carbon monoxide as the starting point is a fortunate one, inasmuch as mixtures of these gases in various proportions may be readily produced by known methods of reducing steam with hot carbon. Similarly, the number of different compounds that it is possible to build from the three elements hydrogen, oxygen, and carbon, is almost infinite, constituting a major field of organic chemistry. It is really this large number of possible compounds that complicates the problem of making any one exclusively thus introducing a new factor which is not encountered in synthesis from such a system as hydrogen-nitrogen, where ammonia is the only possible product of any stability.

The results that have already been realized in producing definite products from the hydrogen-carbon monoxide system furnish a beautiful example of what is possible when the niceties of catalyst selection, choice and control of such conditions as temperature, pressure, and gas composition, are carefully observed. For purposes of discussion, therefore, it serves as an excellent illustration of the factors involved in catalytic synthesis.

Synthesis from Hydrogen and Carbon Monoxide

No direct reaction between hydrogen and carbon monoxide was known until the beginning of the 20th century, when Sabatier, in connection with his extensive and fruitful work on catalysis, observed that carbon monoxide and hydrogen could be made to react in the presence of certain finely divided metals to form methane and water.

$$CO + 3H_2 \longrightarrow CH_4 + H_2O$$

His researches indicated that nickel prepared by the reduction of the oxide was most effective, although other metals such as iron and cobalt were also active. At atmospheric pressure and at temperatures around 200–300°C., the reaction proceeds according to the above equation, if the ratio of hydrogen to carbon monoxide is equal to or greater than the theoretical proportions. Higher concentrations of carbon monoxide and higher temperatures favor the occurrence of side reactions involving the decomposition of carbon monoxide into carbon and carbon dioxide.

It will be noted that the above equation represents the complete hydrogenation of both the carbon and the oxygen of the carbon monoxide. In this sense, it corresponds to complete reaction and is accompanied by a sufficiently large decrease of free energy to permit its going practically to completion over a wide temperature range. In studying the mechanism of this methanation reaction, several investigators suggested that unstable intermediate compounds of hydrogen, carbon, and oxygen, such as aldehydes or alcohols might be formed as an intermediate step. Since

the stability of such compounds is obviously favored by higher pressures, it was a natural step to investigate this system under pressure when the technic of doing this was made available through the work on ammonia synthesis. Such investigations, looking toward the production of methanol as the primary product, were begun a few years ago in both France and Germany.

The formation of methanol according to the equation,

$$CO + 2\,H_2 \longrightarrow CH_3OH$$

is comparable to the synthesis of ammonia, in that both involve a decrease in volume and that both reactions are accompanied by an evolution of energy of the same order of magnitude. Methanol, however, is not the most stable compound that may be formed from the carbon monoxide-hydrogen system, since the reaction to form water and methane, for one, is known to represent a much greater decrease in free energy. The problem here was, therefore, that of so choosing the catalyst and so controlling conditions, as to permit the formation of methanol to the exclusion of other products that are relatively more stable. Many of these factors are disclosed in the reports of the work of Patart in France and of the Badische Anilin und Soda Fabrik in Germany.

In the choice of catalysts, nickel and closely related metals were ruled out because of their known accelerating effect on the methane-forming reaction. The catalysts that were found by experiment to be most effective for methanol synthesis are such difficultly reducible oxides as those of zinc and chromium. Special advantages have been claimed for mixtures of these two oxides and for mixtures of zinc oxide and copper. The disclosures reveal a temperature range between 300° and 600°C., preferably 400°C., and pressures of 50 atmospheres and higher. The type of operation is similar to that employed for ammonia synthesis in that the methanol formed by one pass over the catalyst is removed from the high pressure gas phase as a liquid condensate, after which the unconverted gases are again submitted to the action of the catalyst. The percentage conversion obtained in each pass will depend on the pressure and rate of gas flow.

In producing a single compound like methanol, the proper temperature control of the catalyst is an important factor, since it is difficult to imagine a catalyst capable of retaining its selective action in this system over a very wide temperature range. This control is complicated by the exothermicity of the reaction which may lead to the production of high localized temperatures in parts of the catalyst bed, thus favoring the formation of other reaction products than the one desired. This suggests that the advantages claimed for copper in these catalysts may be associated with its good heat conductivity.

It has been found that the presence in the gases of such almost universal catalyst poisons as sulfur compounds is to be avoided. The publications also stress the necessity of preventing contact of the reacting gases with iron and the occurrence of volatile compounds like iron carbonyl in the gas phase. Copper lined reaction vessels have been prescribed. The bad effect of iron in this system may be due to its catalytic effect on other possible reactions.

The Badische patents state that a gas mixture containing more hydrogen than the theoretical is favorable for methanol formation, while those rich in carbon monoxide favor the production of higher alcohols, particularly if the catalyst contains an alkali such as potassium carbonate.

The preparation from hydrogen and carbon monoxide of higher individual alcohols in a substantially pure state has not been announced. The experimental work of Franz Fischer at Mülheim, however, has resulted in the production of liquid mixtures containing a great variety of organic compounds. This work has had as its objective the conversion of water gas into liquids suitable for motor fuels. Water gas containing on the average 50% hydrogen and 40% carbon monoxide was passed over a catalyst at temperatures between 400° and 500°C. and at pressures between 100 and 200 atmospheres. The catalyst used was iron filings impregnated with alkali hydroxides. The liquid product usually consisted of an aqueous and an oily fraction. It is interesting to note that the use of strong bases for impregnating the iron filings, such as rubidium and potassium hydroxides, favors the formation of oily products, while the hydroxides of weaker bases like those of calcium and strontium yield only water-soluble products. The compounds isolated from these products include alcohols, acids, aldehydes, ketones, hydrocarbons, and esters, some of which contain as high as nine carbon atoms per molecule. In general, the higher homologs occur in the oil layer to which the name synthol has been given. Most of the synthol obtained in these tests distills below 200°C. and after being washed free from acids is suitable for use as a fuel for internal combustion motors. Accompanying the formation of these liquid products there was always some increase in the concentration of methane and carbon dioxide in the gas phase.

The properties of the catalyst are evidently largely determined by the coating of alkali that is deposited on the iron filings. The mechanism by which the larger molecules are built up may involve the condensation of a relatively simple initial compound such as formaldehyde. The very complexity of the products obtained in this work is suggestive of the great possibilities that exist for synthesizing a wide range of compounds of hydrogen, carbon, and oxygen.

Future progress in high pressure catalytic synthesis will obviously be dependent upon the extent to which research is carried on. The general

technic is available and the possibilities of developing a marked selectivity in catalysts have been admirably demonstrated by the methanol synthesis. In addition to the finding of catalysts for definite reactions by rather empirical methods, there is a great need for fundamental research inquiring into the mechanism of the catalytic action for it is through the latter researches that the greatest ultimate progress can be expected.

The employment of high gas pressures has opened up another important field of investigation, namely, the determination of the physical properties of highly compressed gas mixtures. The perfect gas laws and the empirical equations of state that we are accustomed to using around atmospheric pressure are hopelessly inadequate at pressures between 100 and 1000 atmospheres. In addition to the applicability of such data as compressibility, density, viscosity, and heat capacity to the design and operation of industrial plants, such investigations are sure to result in important contributions to our fundamental knowledge of the gaseous state. The equipment for handling highly compressed gases is rapidly becoming standardized, but new systems of reactants may impose new conditions which must be met by suitable changes.

Although the general technic of catalytic synthesis at high pressures may logically be applied to a great many reactions, it seems probable that the attention which has already been directed toward the hydrogen-carbon-oxygen system will be maintained because of the availability of the raw materials and its relation to the great field of organic chemistry.

Show Brass to Be Radio-active. Common brass is radio-active matter, according to Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology, in a statement following recent scientific experiments conducted in brass apparatus placed several fathoms deep in alpine lake waters. This conclusion comes as a by-product of the epochal discoveries of the activities of high-frequency cosmic rays. Incidentally, Dr. Millikan suspects that all matter is capable of spontaneous breakdown, or radio-active decomposition, though evidence in most cases is naturally lacking.

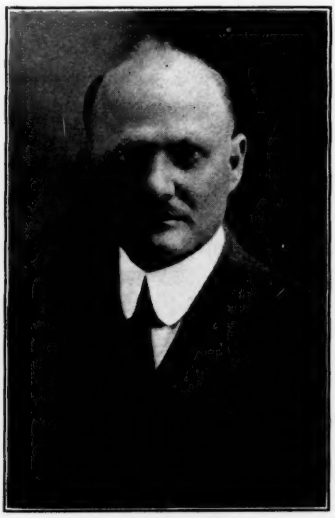
By immersing electroscopes shielded by brass and zinc containers, far down in the icy waters of Muir Lake in the high Sierras, Dr. Millikan was able to shut out even the highly penetrant cosmic rays then under observation. In spite of the reasonable assurance that the lake water, which is merely pure melted snow, contained no radium, it was found that the electroscopes were slowly discharged, showing that both the copper and the zinc in the instruments were slowly disintegrating at a rate fast enough to emit electromagnetic energy in the form needed to effect the electroscope.

Radio-activity—or the transformation of matter into a new species of matter plus new energy—has been considered a special prerogative of a few freak elements, notably radium, uranium, and thorium. It now appears probable that the whole gamut of elements carries such possibilities within one grand system of evolution of matter.—*Science Service*

SUGAR FROM BEETS

A. R. NEES, GREAT WESTERN SUGAR COMPANY, DENVER, COLORADO

The sugar, sucrose, is unique among foods. It is the only important one which comes to us in the form of a highly refined, individual chemical entity. Our other foods—meats, vegetables, and fruits—may be pure in the sense that they are wholesome and free from adulteration, but chemically they are very complex. Sucrose is a simple chemical compound manufactured in Nature's laboratory and stored in the tissues of certain plants. It is the business of the sugar refiner to extract this sugar and separate it from the other constituents of the plant juices. This is done so successfully that the sugar industry has become one of the largest producers of pure chemicals in the world. About 25,000,000 tons of refined sugar having a purity comparable to that of the "C. P." chemicals on the laboratory shelves were produced last year. More than one-fifth of this amount was consumed in the United States. In this country sugar supplies about fifteen per cent of the twenty-five to thirty-five hundred calories of energy required to keep the body of the average individual functioning for one day. The popularity of sugar in the diet is not accidental, nor is it solely because of its pleasant taste. It supplies a real need; it is easily digested and quickly and completely assimilated, supplying energy to the system in a more concentrated and more quickly available form than any other substance.



A. R. NEES

The total refined sugar output is derived from two sources: the sugar cane, which can only be grown in tropical and semi-tropical countries, and the sugar beet, which thrives best in temperate climates. We shall confine our discussion more particularly to the production of sugar from beets. It may be surprising to some people to learn that nearly one-half of the world's supply of sugar comes from beets; nevertheless, in normal times, this is true. During the war years the European production of beet sugar was greatly curtailed and the ratio of beet to cane fell to less than one-third. At the present time, however, they are again approaching a fifty-fifty basis. In the United States, last season, Louisiana cane produced 88,000 tons of sugar (about one-half the usual production) while

the beet industry produced 1,095,000 tons, or about twenty per cent of our total consumption. The production of beet sugar, therefore, occupies a position of importance in our industrial and economic scheme.

The sugar beet, or rather its antecedents, have been known and cultivated for many centuries in Asia, Northern Africa, and Europe. Its origin is unknown. The beets were grown largely as a forage crop, although Herodotus states that the builders of the pyramids used them for food.

Andreas Marggraf of Berlin (in 1747) was the first to crystallize sugar from beets. He did this by extracting the pulped root with alcohol and allowing the extract to stand until crystallization occurred. About 50 years later Achard, a student of Marggraf, made ten pounds of refined sugar from forage beets grown in Silesia. This he presented to the King of Prussia, who was so much interested that shortly after, in 1802, he sponsored the building of the first beet sugar factory. In this factory, three pounds of refined sugar were produced per hundred pounds of beets. At the present time about fifteen pounds of sugar are produced per hundred pounds of beets. The industry received its first real impetus during the Napoleonic wars, when the French government placed a bounty on sugar and compelled the peasant farmers to plant sugar beets. However, after the fall of Napoleon the European ports were again opened to the cheap sugar from the tropics and the newly established beet sugar industry was unable to hold its own. Only one factory survived the reconstruction period following the close of the wars.

Up to this time the beets used were of poor quality, containing only five to six per cent sugar. In 1821, Pelouze, a botanist, through researches in plant breeding was able to materially increase the sugar content of the beets. From this time on the industry was able to obtain and hold a firm footing, and to spread rapidly through the various countries of Europe. Germany, Russia, Austria-Hungary, France, Belgium, Netherlands, and Italy became the chief producers, in the order named.

The first beet sugar factory in the United States was erected at Philadelphia in 1830. The venture was unsuccessful and only a few hundred pounds of sugar were produced before it was abandoned. Other factories were built in several Eastern states and in Utah, Illinois, Wisconsin, and California. All were failures. In 1879 E. H. Dyer, after four complete financial failures and reorganizations, succeeded in putting a plant at Alvarado, California, on a paying basis. This was the first commercially successful beet sugar factory in the United States. Since 1890 the growth of the industry has steadily advanced, and at the present time about one hundred factories are in operation.

It is an interesting fact that in this country beets have been successfully grown only in a rather restricted area, which consists of a narrow belt extending along the Great Lakes and on westward across Minnesota,

Iowa, Nebraska, Colorado, Wyoming, Montana, Utah, Idaho, and California. No one seems to know just what advantages of soil and climatic conditions are possessed by this region, the boundaries of which are rather sharply defined. No doubt further developments in agricultural methods and researches in plant breeding will, in time, greatly extend the profitable beet-producing territory.

The success of the world's beet sugar industry has been dependent upon the correlation of two widely different lines of endeavor. One has to do with the purely agricultural problem of producing a satisfactory yield of beets containing the highest possible amount of sugar, and the other has to do with the chemical engineering problem of extracting and refining the sugar with the greatest efficiency and dispatch.

The growing of sugar beets is a highly specialized agricultural problem and the development of the beet to its present state of productivity and sugar content is one of the outstanding accomplishments in plant breeding of the past hundred years. It has been stated that originally the beets contained only five to six per cent sugar. By a very careful and painstaking process, in which only those beets which conformed to certain standards of form and sugar content were selected to produce seed, the sugar content has been increased more than three-fold. At the same time the yield of roots was also greatly increased, so that the sugar produced per acre has increased in even greater ratio. The sugar beet is one of the most highly bred plants under cultivation and constant attention is needed to prevent it from degenerating into a prototype of its impoverished ancestors. Indeed, one of the essential phases of the beet sugar industry is the production of pure-bred seed from carefully selected individuals. It is an exacting business, requiring the best efforts of highly trained botanists and agriculturalists. This supervision of experts does not stop with the production of the seed. Beet growing is unique among agricultural activities in that the purchasers of the crop, the sugar companies, maintain a staff of trained men whose duty it is to aid and advise the growers in the best methods of planting, growing, and harvesting. The production of the raw material, *i. e.*, the growing of beets is, therefore, recognized as an industry separate and distinct from the refining of sugar just as mining is distinct from metallurgy.

We often hear the expression "sugar factory" and we speak of the "manufacture" of sugar. Such expressions are not strictly correct. We do not manufacture sugar. Sugar is manufactured through the life processes of the plant and is stored up in the form of a dilute solution in the cells of certain tissues, to be used by the plant as a source of reserve food material. Man, through his inquisitiveness, has learned that this food is good and he has further learned that it is even more palatable if it can be separated from the other substances present in the plant juices.

It is here that the sugar "factory" begins to function. Its business is to extract the sugar from the plant cells and to separate it from the other soluble substances which naturally accompany it. The "manufacture" of sugar as we commonly think of it is, therefore, in reality a chemical refining process, a rather complicated one, it is true, but an extremely interesting one. Advantage is taken of nearly all of the processes which the chemist is accustomed to carry out in his laboratory. There is diffusion, precipitation, calcination, evaporation, filtration, and crystallization. Reactions are caused to take place between substances in solution, between gases and substances in solution, and between solid reagents and substances in solution. All of these efforts are directed toward a single goal, the separation of the sugar in the form of pure, crystalline sucrose.

In a beet house the process proceeds somewhat in the following fashion. The beet roots are brought into the mill and thoroughly washed to remove the adhering soil particles. They are then sliced into thin chips or cossettes, known in sugar house parlance as "noodles." If one can imagine noodles having a V-shaped cross section, the term is a very apt one. The cossettes go directly to the diffusion battery, which consists of a number of cells holding three to five tons each. Here the sugar is washed out of, or diffused from the plant tissue by a process of counter-current leaching with hot water. Thus the first step is completed; the sugar has been separated from the insoluble portion of the beet. The solution thus obtained is called "diffusion juice."

Unfortunately there are a number of other substances which are also soluble and which are extracted along with the sugar. These non-sugars make up about twelve to sixteen per cent of the total solids in the juice. Now comes the more difficult task of separating soluble sugar from soluble and colloidal non-sugars. Obviously, there are two methods of attack, *i. e.*, the non-sugars may be precipitated, leaving the sugar in solution, or the sugar may be precipitated, leaving the non-sugars in solution. In practice both methods are used. Neither is perfect, so that in the end there remains a mixture of sugar and non-sugars which cannot be economically separated. This mixture is the final molasses.

It has been found that certain of the non-sugars are comparatively easy to remove, so they are taken out first. Milk of lime is the reagent used to effect this initial step in the purification. Some of the substances are precipitated in the form of insoluble lime compounds, and others which are of a colloidal nature are coagulated in the highly alkaline solution. In order that the juice may not be contaminated with soluble lime and to render filtration easy, carbon dioxide is passed into the mixture and nearly all of the lime is converted into insoluble calcium carbonate, which is then filtered off, along with the precipitated non-sugars. A

second treatment by carbon dioxide and still a third treatment by sulfur dioxide are required to remove the remainder of the lime.

After this treatment there still remains about ten per cent of non-sugars on total solids in the juice. No method is known by which these can be economically removed, so advantage is taken of the other alternative, precipitating the sugar, first by crystallization and later by chemical means, and leaving the impurities in solution. At this stage the juice contains about twelve per cent sugar, so the first step is to increase the concentration by the evaporation of water. This is done in multiple-effect evaporators under reduced pressure. The concentration is continued until the juice contains about sixty per cent sugar. After a final filtration, to remove the last traces of suspended matter, the juice is sent to the vacuum pans where the evaporation is continued under carefully controlled conditions. The juice soon becomes supersaturated with respect to the sugar, which then begins to crystallize. When the proper point is reached, the mass of crystals and sirup is removed from the pan and the crystals are separated from the mother liquor and carefully washed and dried. These crystals constitute the familiar granulated sugar which we know so well. The mother liquor, of course, still contains a great deal of sugar, so it is further concentrated and a second crop of crystals is obtained. By this time, however, the proportion of non-sugars has increased to such an extent that the sugar is not of the highest purity and it becomes necessary to employ the process of recrystallization. The impure or "raw sugar" is dissolved in water or dilute liquor and mixed with the juice from which the pure sugar is being made.

The process of crystallization is continued until the mother liquor, or molasses, contains about forty per cent non-sugars on total solids, at which point it is no longer practical to continue the separation of sugar by this means. In order to make a further recovery of sugar it becomes necessary to resort to a chemical means of separation. Dry powdered quick lime, calcium oxide, is added to the diluted molasses solution and the sugar is precipitated in the form of an insoluble tricalcium sucrate. This is filtered off, leaving about ninety per cent of the non-sugars in the filtrate, which is discarded. This calcium sucrate can be used instead of milk of lime in the initial step of juice purification. The carbon dioxide decomposes it into calcium carbonate and sugar. Thus the same lime is made to serve two purposes, to remove the sugar from the impurities in the molasses and then in turn to remove impurities from the original diffusion juice. However, this apparently perfect cycle has its limitations. It is found that there are certain non-sugars which cannot be precipitated from the diffusion juice by lime and neither can they be removed and discarded in the filtrate from the calcium sucrate. The continually increasing concentration of these substances makes it necessary to dis-

card a certain amount of molasses from time to time, the sugar in which cannot be recovered and refined by the present processes.

This final or discard molasses and the insoluble portion of the beet, called the pulp, constitute the two chief by-products of the beet house. A part of the molasses is used for the production of alcohol and yeast. The remainder of the molasses and all of the pulp is fed to cattle and sheep, thus further enhancing the agricultural value of the beet crop.

The description of the process has, necessarily, been made very brief and only the essential steps have been touched upon. However complicated it may be in its details, and whatever engineering problems have had to be solved in bringing the industry to its present state of development, it is, as we have pointed out, essentially a chemical refining process not much different from those encountered by the chemist in separating and determining compounds and elements in the course of routine analyses or in the preparation of laboratory reagents. The same fundamental laws must be recognized and obeyed and the same meticulous care and attention to detail must be observed in order that successful achievement be attained.

Mineral Resources a Serious World Problem. That a commercial League of Nations may possibly be established to help settle the world's problems with regard to mineral resources is foreseen by Dr. Charles K. Leith, well-known geologist from the University of Wisconsin, attending an international meeting of geologists in Madrid.

Dr. Leith points out that a mighty conflict is going on between two powerful forces: world demand for the needed supply of minerals, and, on the other hand, nationalist forces which are working to use the mineral resources of a political state for national gain or protection.

Mineral resources are very unequally distributed among the countries of the world, Dr. Leith states, and in many cases the great centers of supply constitute essentially national monopolies. The dependence of modern civilization upon these unequally divided minerals is growing and the problem of mineral resources figures largely in the consciousness of nations.

"The satisfaction of world demand for minerals must, therefore, over-ride political boundaries," said Dr. Leith. "There seems to be no way to eliminate either set of forces. The problem is to effect a balance or adjustment between them.

"Internationalization of resources, in the sense of turning them over to some supernational control, is probably a political impossibility, even if it were desirable, which is doubtful. But there is an opportunity to standardize by international agreement the many international commercial arrangements which are now effecting a fair and workable compromise between world demand on the one hand and nationalistic policies on the other."

Dr. Leith advocates an international economic conference, with fact-finding committees, and "ultimately, perhaps, what will amount to a commercial League of Nations." This, he said, would not put an end to national mineral monopolies, nor would it cause a nation rich in minerals to lose the advantages of these possessions.—*Science Service*

PANDEMIC CHEMISTRY

WILDER D. BANCROFT, CORNELL UNIVERSITY, ITHACA, N. Y.

The universities have two functions in the teaching of the sciences. They should teach a science as a professional study and as a cultural study. In the case of chemistry the universities teach chemistry fairly well as a professional subject for the chemists, the medical men, the biologists, the engineers, etc. So far as I know, there is no university which now teaches chemistry as a cultural study—as a part of a general education. In almost all places the unfortunate student who would like to learn something about chemistry is forced to take the introductory or freshman course in chemistry. This is, and must necessarily be, entirely unsatisfactory. Freshman chemistry is avowedly and properly a professional course. It leads up to qualitative and quantitative analysis, to organic chemistry, to physical chemistry, and to other advanced courses in chemistry and medicine.

The course in general chemistry does not cover enough ground to be of real value to the student seeking a general education and it goes into far too much detail for him. The better it is as a professional course the worse it is as a cultural course. With the exception of Syracuse University all the universities about which I happen to know take up the metals at the end of the course. This is quite wrong for a cultural course because the student should start with things that he knows about. Gold, silver, copper, iron, lead, tin, aluminum, nickel, zinc, and platinum are household words to everybody. The sooner one can begin talking about the metals, the more quickly will the student see the bearing of what he is being taught. The metals are about the only chemical elements that the average man handles.

Since chemistry is the fundamental science, one which we are always encountering in some form and in some place, it is particularly desirable that everybody should have some knowledge of chemistry; and yet the teaching chemist does nothing to make this possible. We have nobody but ourselves to thank for it. The chemists complain, and very properly, that the business men and the bankers are deplorably ignorant of chemistry; but the chemist provides no way for the prospective business man to get even the most rudimentary knowledge of chemistry as a whole.

What we need as a cultural course in chemistry is a course which will cover all the ground in chemistry given in the universities without going into too much detail. This means a series of popular lectures covering the whole field of chemistry as well as it can be done in the time. I urge the giving of a course of this sort, primarily for the benefit of the man who is expecting not to go on in chemistry. This course will be called "pandemic chemistry" (pandemic—of, or pertaining to, all the people). Almost all chemists are agreed that such a course should be given, but the difficulty

is to decide just what ground it should cover. I have been working on this problem for a number of years and I have discussed it with a good many chemists. Through the assistance of Mr. Francis P. Garvan, president of the Chemical Foundation, I was able to secure the services of Dr. Edward P. Phelps, now professor of chemistry at Marshall College, to work out for me lecture notes for those portions of the course about which I knew relatively little. I am deeply indebted both to Mr. Garvan and to Dr. Phelps.

I am now ready to give a tentative outline of what I think should be included in a course on pandemic chemistry. The division into lectures is, of course, arbitrary. Some topics will need more time than I have assigned to them and others will require less; but I don't yet know which is which. The line of approach is in all cases from things about which the student knows. Hydrogen is used in balloons; helium is the non-inflammable gas used in the Shenandoah. Nickel is familiar from nickel-plated skates and bicycles. We have mercury in our thermometers and we paint a sprained thumb with a solution of iodine. So it goes all along the line. Everybody knows about quick-lime and slaked lime. Very few people except chemists know anything about barium hydroxide. If one is to mention barium hydroxide, it must come through its relation to lime. They tell a story of Louis Agassiz which always appealed to me. Before the opening of a session at Penikese Island, somebody said: "I suppose you will begin with a general classification." "No," said Agassiz, "I shall begin with a bushel of clams."

Pandemic Chemistry

Lecture 1.—What is the world made of and how is it made? What are salt, sugar, marble, granite, etc.? Wind makes us conscious of air. Mixture of oxygen and nitrogen. Pressure-volume relations. Absolute temperature. Other gases and their densities: hydrogen, helium, sulfur dioxide, carbon monoxide and dioxide, chlorine.

Lecture 2.—Water—liquid to vapor and liquid to solid. Evaporation and boiling point. Geysers. Mercury, ammonia, etc. Liquefaction and solidification of gases. Critical temperatures and pressures. Commercial production of compressed gases.

Lecture 3.—Solubility and Crystallization. Alcohol and water in the radiator. Fractional distillation of ordinary liquids and of liquid air. Dewar flask and thermos bottle. Properties of materials at liquid air temperatures.

Lecture 4. General Properties of Metals.—Copper, gold, silver, iron, aluminum, tin, lead, nickel, zinc, mercury, platinum, tungsten. List of metals with specific gravities, melting points, boiling points, and electrical conductances.

Lecture 5. General Properties of Alloys.—Brass, bronze, aluminum bronze, duralumin, magnalium, cupro-nickel, Monel metal, German silver, constantan, manganin, invar, nichrome, gold alloys, silver alloys, soft solder, Babbitt metal, type metal, Wood's alloy, alloy steels.

Lectures 6–7. General Properties of Non-Metals.—Carbon, diamond, graphite, coal, coke, sulfur, phosphorus, oxygen, nitrogen, chlorine, iodine, hydrogen, bromine, arsenic, silicon, selenium, helium, argon.

Lecture 8. Elements and Compounds.—Definition of elements and compounds.

Law of definite and multiple proportions. Atoms and molecules. Gram-molecular weights. Formulas and valence. Avogadro's number.

Lecture 9. Acids, Bases, and Salts.—Sulfuric, hydrochloric, nitric, boric, phosphoric, acetic, butyric, oxalic, lactic, citric, and tartaric acids. Sodium, potassium, calcium, and ammonium hydroxides. Sodium carbonate, sodium bicarbonate, borax, sodium chloride, sodium nitrate, potassium nitrate, sodium sulfate, ammonium sulfate, calcium phosphate, calcium carbonate, water glass, vermilion, alum.

Lecture 10. Qualitative Analysis.—Detection of metals. Detection of acids.

Lecture 11. Quantitative Analysis.—Gravimetric analysis: brass and lead. Volumetric analysis: hydrochloric acid and silver.

Lectures 12–13. Organic Chemistry.—Hydrocarbons; halogen derivatives of hydrocarbons, alcohols and phenols, ethers, aldehydes and ketones, acids, esters (including fats), carbohydrates, amines, amino acids, proteins, and other nitrogen compounds.

Lecture 14.—Fire and flame: spectrum analysis.

Lecture 15.—The periodic law.

Lecture 16.—Isotopes.

Lectures 17–19. Electrochemistry.—Electroplating and electrolytic refining; electrolytic chlorine, etc. Sodium, aluminum, and magnesium. Electric furnace products: phosphorus, carborundum, graphite, alundum, calcium carbide. Storage battery, etc.

Lecture 20. Rocks and Minerals.—Granite, limestone, marble, slate, soapstone, conglomerate, glassy rocks. Rock salt, potash salts, asbestos, talc, gypsum, mica, calcite, garnet, quartz, feldspar.

Lectures 21–22. Occurrence and Extraction of the Metals.—Copper, gold, silver, iron, tin, lead, nickel, zinc, mercury, platinum, tungsten.

Lectures 23–25. Manufacture of Heavy Chemicals, etc.—Sulfuric acid, hydrochloric acid, nitric acid, sodium chloride, borax, sodium carbonate and bicarbonate, water glass, sodium nitrate, lime, bleaching powder, superphosphate, alum, aluminum sulfate, ammonia and ammonium salts, white lead, potassium salts, zinc salts, lithopone, copper sulfate, ferrous sulfate, magnesium sulfate, sulfur.

Lecture 26. Catalysis.—Contact sulfuric acid, nitrogen fixation, hydrogenation, etc.

Lectures 27–29.—Coal, coke, gas and oil, tar, and asphalt.

Lecture 30.—Destructive distillation of wood.

Lectures 31–33.—Soaps, fats, oils. Water purification and washing.

Lectures 34–38.—Glass, pottery, plaster, cement, building stones (marbles, etc.).

Lecture 39.—Gelatin, glue, and other adhesives.

Lectures 40–41.—Tanning of hides.

Lectures 42–43.—Rubber.

Lectures 44–45.—Textiles, wood, and paper.

Lectures 46–48.—Cellulose nitrate: collodion, celluloid, films, rayon.

Lectures 49–51.—Dyeing, printing, and writing.

Lectures 52–53.—Photography.

Lectures 54–57.—Dyes and explosives; war gases.

Lectures 58–59.—Matches, fireworks, etc.

Lectures 60–62.—Paints and varnishes.

Lectures 63–64.—Structural colors.

Lectures 65–66.—Phosphates and fertilizers, plants and acid soils, ferrous sulfate, and dandelions.

Lecture 67.—Fermentation.

Lecture 68.—Distillation of liquors; perfumes.

Lecture 69.—Milk, butter, and cheese.

Lectures 70–71.—Cooking, eggs, cocoa, bread, etc.

Lectures 72–73.—Food values, vitamins, etc.
Lecture 74.—Chemistry and medicine.
Lecture 75.—Chemistry and myth. Kalewala.
Lecture 76.—Lost arts.

It is evident that a course such as outlined will not teach a student any chemistry to speak of. It is not intended to; but it will teach him *about* chemistry and it will give him an interest in chemistry which will stay by him throughout his life. The course is intended primarily for those who do not expect to go farther in chemistry—in other words for those who wish to get a cultural course in chemistry and for those who are required to take chemistry to complete the underclass requirements in science. To this extent it will relieve the strain on the freshman chemistry and will thereby make it possible to improve that course.

The course in pandemic chemistry will undoubtedly be taken by all the graduate students in chemistry—presumably without credit—to give them a perspective, which they don't get now. It will probably be taken by a certain number of graduate students in physics, biology, etc., who would like to get a bird's-eye view of the field of chemistry. I may be wrong about this last, but I am basing my opinion on the fact that several graduate students in chemistry have told me that they would like to take a course in pandemic physics or pandemic biology.

Professor Phelps has tried out the first half of this course on a small class at Marshall College. Professor Findlay is hoping to introduce pandemic chemistry at the University of Aberdeen before long. Yale University is going to try a modified form of it this Autumn, although there it is planned to be to some extent a substitute for the orthodox freshman chemistry. At Cornell we are still hoping that somebody will endow the first chair of pandemic chemistry in the world. It is a wonderful opportunity for somebody to start a new era in university education because all the leading universities will follow suit in time. In addition to the chairs in pandemic chemistry, there will eventually be chairs in pandemic physics, pandemic biology, etc., and perhaps, some day, a chair in pandemic science.

The proposed course in pandemic chemistry is interesting from another viewpoint. Since most of the students in the public schools do not go to college, it would be much better for them to have a course in pandemic chemistry rather than the introductory course which they now have. Before that can come to pass, we shall have to have a text-book for the students to study, we shall have to have teachers competent to give instruction in the subject, and we shall have to educate the colleges to the point of accepting this work for college entrance. This will take much time, although a text-book must be written at once for the benefit of the college student. It is merely a question of time, however, when this

reform will go through in the schools and in the colleges. When that time comes, people will wonder why it was not done long before.

In "The Humanizing of Knowledge," James Harvey Robinson says that the great aim of modern education is to develop such abilities; inclinations, and ideals as may qualify our youth to take an intelligent and effective part in an evolving society. He adds, "I wonder why we should think of history, economics, politics, and geography as distinctively social sciences; language is pretty social too; and why is geography more social than chemistry or physics or botany? The importance of all of them lies in their relation to ourselves and our fellowmen."

Washed Animal Blood May Save Human Lives. Important experiments on blood transfusion, made by Prof. Yourevitch and Mlle. Teleguina of Prague, appear to lead to the conclusion that special human blood donors will no longer be required in cases where transfusion is necessary to save a patient's life. The blood of a sheep or a cow might serve the same purpose and special preparations of solution could be made in advance, and kept in bottles until required.

It has long been known that the most important point about blood in regard to transfusion is its specificity. That is to say, a rabbit can only be saved by the injection of the blood of another rabbit. If the blood of a different animal is injected into its tissues, it dies immediately. In the case of human beings blood has been divided into four groups. When an injection has to be made, the blood of the patient has first to be tested to see which group he belongs to. Only rare individuals of the fourth group can give blood to any of the others with beneficial and not dangerous results.

Prof. Yourevitch and his woman colleague have opened up an entirely new line of treatment. They separated the red blood corpuscles from the serum by centrifuging methods. They found that the poisonous qualities, which on injection have such harmful effects, are in the plasma, and that if the separation or "washing" is thoroughly carried out the red blood corpuscles of an animal of one species can be injected into another without the slightest danger, but, on the contrary, with completely satisfactory results.

Rabbits which had lost an absolutely fatal quantity of blood could be saved by the injection of sheep's blood which would have been highly poisonous to them, provided only the washed red corpuscles were injected.

A rabbit which had received 10 to 15 cubic centimeters of unwashed ox blood died within five or six minutes. Another rabbit was given similar blood which had been partially washed, added to some of its own. After a period of serious prostration it recovered. But a rabbit which had received only the red blood corpuscles of ox blood, which had been thoroughly washed, recovered completely without any detrimental symptoms.

It is confidently suggested by the investigators that in cases where human blood of the right group is not immediately available for transfusion, blood of any other group would be equally beneficial, provided only the washed red corpuscles were used. They also indicate that in their opinion blood of animals could probably be used in the same manner, if no human blood could be obtained.

It is further stated that a preparation of red blood corpuscles in a salt solution has been kept perfectly in bottles, and that there is no reason why such a preparation could not be made up in a standard manner and stocked for use according to necessity.—*Science Service*

RESEARCH ON ELECTRODEPOSITION AT THE BUREAU OF STANDARDS*

WILLIAM BLUM, BUREAU OF STANDARDS, WASHINGTON, D. C.

The principal industries in which the electrodeposition of metals is applied on a commercial scale are electro-refining, electro-winning (the recovery of metals from solutions produced by extracting ores), electroplating, and electroforming. The latter, a recently coined term, includes electrotyping for the printing industry, and the production of tubes, sheets, and other articles by electrodeposition. Of these processes, the first two are usually carried out on a large scale under direct chemical supervision. Electroplating and electrotyping are, however, mostly conducted in relatively small plants, and even when they are carried on in large establishments as in the automobile and printing industries, they have often been considered as minor or incidental processes.

In consequence there was up to a decade ago very little direct application of science in commercial electroplating and electrotyping. The work was mostly conducted by empirical methods, and in many cases an attitude of secrecy was maintained. In recent years, however, a great demand has arisen from electroplaters and electrotypers for more definite scientific information upon principles of operation and methods of control. It is to meet just such demands that the Bureau of Standards has conducted researches on electrodeposition during the past ten years. In order to obtain a knowledge of existing conditions and needs, and to provide channels for the distribution and application of the results of research, the Bureau has coöperated actively with such organizations as the American Electroplaters' Society and the International Association of Electrotypers.

A survey of the voluminous literature on electrodeposition indicates that there is a considerable gap between the existing scientific data on such subjects as conductivity, electrode potentials, and overvoltage, and the application of these data or even of the principles to actual practice. It has, therefore, seemed expedient to make such studies as will serve to bridge this gap, rather than on the one hand to determine physical constants with high precision or on the other hand to confine the work to purely empirical problems of plating, such as can often be equally well solved by experienced platers with moderate scientific training and equipment. Thus from the standpoint of this industry there is no justification for determining to a precision of one part in one thousand or better, the conductivities of plating solutions which may and do vary in composition from day to day by several per cent. It is far more important to know what effects the conductivity may have upon the opera-

* Published by permission of the Director, Bureau of Standards, Department of Commerce, Washington, D. C.

tion of the baths, and upon the character and distribution of the deposits; and to be able to predict the best practicable means for controlling the conductivity.

The methods and scope of the studies in progress at the Bureau may best be illustrated by the results obtained during the past few years on nickel deposition, which constitutes the largest single application of electroplating. Many of these principles will, no doubt, find application in the deposition of other metals to be studied in future researches.

The fact that nickel plating solutions must be nearly neutral, naturally suggested the measurement and control of the hydrogen-ion concentration or p_H of these solutions. The results obtained,[1] in both the laboratory and plant have led to the conclusion that the p_H is the most important single factor in nickel deposition. All nickel solutions under usual operating conditions have a p_H between 5.5 and 6.5, and a change of 0.2 p_H may produce a definite effect upon the appearance of the deposited nickel. It is obvious, therefore, that such crude tests for acidity as that with litmus paper are entirely inadequate. Modern methods of measuring p_H with indicators have, therefore, been applied by means of simple portable devices in which the required color standards are furnished by either (*a*) standard buffered tubes, (*b*) drop ratio tubes, or (*c*) a sliding double wedge. To many platers who successfully use these devices, p_H is merely a number with little physical significance, but its use permits them to measure and control the acidity of their solutions and thus eliminates one frequent cause of difficulty.

In the texts on electrochemistry frequent and extended references are made to the static or equilibrium potentials of metals in their solutions, but little or no space is given to the single potentials during deposition, *i. e.*, the dynamic potentials. It is true, as is often pointed out, that these dynamic potentials, and hence the polarization, cannot be predicted from existing data. They can, however, be measured by means of a simple potentiometer, and what is more important, they can be used in the study of practical problems. The need for more study of the polarization during deposition may be judged from the fact that it determines largely (*a*) what process will take place at an electrode and at what current efficiency, (*b*) the distribution of the metal upon the cathode surface, *i. e.*, the throwing power, and (*c*) the structure and properties of the deposited metal.[2] In short, it is possible to gain an insight into the processes of electrodeposition, only by a study of the potentials at the electrodes during electrolysis.

From a study[3] of "throwing power" in a simple apparatus, it was con-

[1] M. R. Thompson, *Trans. Am. Electrochem. Soc.*, **41**, 333 (1922).
[2] W. Blum and H. S. Rawdon, *Ibid.*, **44**, 397 (1923).
[3] H. E. Haring and W. Blum, *Ibid.*, **44**, 313 (1923).

cluded that three, and only three, factors enter, *viz.*, cathode polarization, conductivity of the solution, and cathode efficiency. From measurements of these properties it is possible to compute and predict the *relative* uniformity of distribution of metal upon an article, although it is still impracticable, and usually unimportant, to predict the *actual* distribution on any irregularly shaped article. With a knowledge of the results thus far obtained upon the throwing power of nickel and copper plating solutions,[4] it is possible for an experienced plater or chemist to select those operating conditions which will furnish the most nearly uniform distribution of these metals.

Because a knowledge of polarization is so essential to an understanding of electrode processes, efforts, which now appear promising, are being made here to develop simple inexpensive equipment for measuring polarization. With such equipment it is hoped that the measurement of polarization will become a practical, rather than an academic problem, as it is now too frequently considered. Thus, for example, it is reasonable to predict that through polarization studies far more light may be thrown upon the mechanism by which so-called "addition agents" influence the structure of electrodeposits than through further extension of the empirical observations now found in the literature.

Another application of cathode potentials and polarization is in the plating of one metal upon a less noble metal, *e. g.*, of nickel upon zinc or zinc-base die castings. From a study[5] of such potentials it was found possible to successfully predict the favorable solution composition and operating conditions, before any actual experiments were made upon the plating of nickel on zinc.

In a study conducted here it was found[6] that the measurement of anode potentials and anode polarization threw light upon the behavior of nickel anodes of various compositions and structures. Much further study will be required, however, before a comprehensive or adequate theory of passivity and its relation to electrodeposition can be developed.

The effects of impurities[7] upon the composition and physical properties of nickel deposits are determined primarily by the potentials at which they are deposited from solutions containing small concentrations of such metals and a high concentration of nickel. Some of the effects observed may be predicted from the respective static potentials, others involve polarization and possible alloy formation. While the results obtained led to definite and satisfactory specifications for nickel salts,

[4] H. E. Haring, *Trans. Am. Electrochem. Soc.*, **46**, 107 (1924).

[5] M. R. Thompson, *Ibid.*, **47**, 163 (1925).

[6] C. T. Thomas and W. Blum, *Ibid.*, **45**, 193 (1924).

[7] M. R. Thompson and C. T. Thomas, *Ibid.*, **42**, 79 (1922). M. R. Thompson, *Ibid.*, **44**, 359 (1923). H. E. Haring, *Ibid.*, **46**, 107 (1924).

further study will be required to yield a complete explanation of the effects of certain impurities.

The study of conductivities[8] of nickel sulfate solutions containing various added salts, showed that the effects of such salts are usually roughly parallel to their respective conductivities when alone. With the present inadequate data and theories, it is practically impossible to make even semi-quantitative predictions regarding the conductivities of strong solutions of mixed salts. Empirical tables must, therefore, be prepared.

In researches now in progress, efforts are being made to apply to other subjects, *e. g.*, zinc plating and chromium plating,[9] the principles illustrated in the study of nickel. Even though such applications may prove possible and helpful, it has been found, as might be anticipated, that for various metals the relative effects of different variables may be of quite different orders. The plan of the study and the interpretation of results are, however, greatly aided by the use of such general principles as have been referred to above.

A popular account of the methods used in the plating industry is contained in Chapter VIII of Vol. II of "Chemistry in Industry." Suggestions regarding methods of teaching the important principles are given in a recent article in THIS JOURNAL.[10]

From this brief review of these studies at the Bureau of Standards, together with the fact that many researches on electrodeposition are now being conducted in university and industrial laboratories, it is evident that there is an increasing demand for research in this field. The fulfillment of this demand will require persons with training and perspective in the fundamental principles, such as can best be taught in sound college courses in physical and electrochemistry. The field is large and there is room and need for active participation by our educational institutions, both in research and teaching. Only through such coöperation will it be possible to place this important industry upon a scientific basis.

[8] L. D. Hammond, *Trans. Am. Electrochem. Soc.*, **45**, 219 (1924).
[9] H. E. Haring, *Chem. & Met. Eng.*, **32**, 692 (1925); **32**, 756 (1925).
[10] W. Blum, THIS JOURNAL, **2**, 556 (1925).

FOURTH NATIONAL COLLOID SYMPOSIUM

The Fourth National Colloid Symposium will be held at the Institute of Technology, Cambridge, Mass., June 23rd, 24th, 25th. Professor James W. McBain, Leverhulme Professor of Physical Chemistry in the University of Bristol, England, is the guest speaker. Inquiries about papers should be sent to Dr. H. B. Weiser, Rice Institute, Houston, Texas. Other inquiries, as well as notice of your purpose to attend the Symposium, should be sent to Mr. Brian Mead, Secretary of the Local Committee, Institute of Technology, Cambridge, Mass.

THE VALUE OF INSPECTION TRIPS AS AN ADJUNCT IN THE TEACHING OF APPLIED CHEMICAL PRINCIPLES

D. S. CHAMBERLIN, LEHIGH UNIVERSITY, BETHLEHEM, PA., AND M. K. BUCKLEY, YALE UNIVERSITY, NEW HAVEN, CONN.

In teaching the applied principles of any science, the best results can be obtained, not by a mere abstract consideration of them, but by concrete examples of their application and a visualization of their practical results. For this reason, a course in technical or engineering chemistry cannot be considered as complete unless accompanied by plant inspection, which acts as a basis for thoughtful and fruitful discussion concerning the economic results obtained.

For the most efficient instruction in such a course, the presentation of the basic principles of chemical engineering, the so-called unit processes, that is (*a*) transportation of solids, liquids, and gases, (*b*) crushing, grinding, and pulverizing, (*c*) sedimentation, elutriation, and flotation, (*d*) solution and crystallization, (*e*) evaporation and distillation, must be clearly and thoroughly enunciated before any one chemical manufacturing process is studied. When this fundamental material has been mastered, then specialization along given lines may be undertaken.

The study of these unit processes should be presented with the aid of a well-planned laboratory course, lectures illustrated by reference to trade journals and catalogs, and supplemented by numerous problems dealing with installation, power requirements, upkeep, heat balance, etc., the end in view being the design, equipment, and installation of a small plant. A large and elaborately equipped workshop, fitted with demonstration size units of specialized apparatus is unnecesssry to teach such principles as filtration, sedimentation, distillation, crystallization, drying, etc. Equipment such as is found in any ordinary laboratory, manipulated with a little ingenuity, can be used to teach fractional crystallization; for instance, the production of barium nitrate from witherite, muriatic acid and Chili saltpeter; starch and corn sirup from corn, etc. From results so obtained, the design for a small sized plant can be drawn.

The interest of a student in the study of these principles can be sustained and strengthened by seeing some industrial process in operation, and his gram laboratory chemistry evolved into carload plant chemistry. For this purpose, inspection trips must be considered as a necessary requirement in the training of a technological chemist. For the best results to accrue from an inspection trip, a plan of study of the plant and the procedure through the plant must be mapped out with as much care as in the study of fundamentals.

A tenet which to the authors appears self evident, is that inspection trips should not be taken until *the student is prepared to understand what he sees*. It was found by them, however, that in several institutions

such trips were scheduled before the opening of the college term in order that the plants visited might be used as examples of definite type processes which were studied during the term and after such trips.

Such a procedure cannot be of maximum benefit to the student; he will not have mastered the process in the plant and he will be unable to recall an operation which he did not understand. To obviate this, trips should be planned to occur at mid-term or at other convenient times after the student has acquired a fair grasp of chemical engineering fundamentals. Fortunately, some of our colleges are situated in rich chemical centers, allowing inspection trips of half-day and day periods. After a thorough ground work in a particular process, inspection of operations covering this group of chemical fundamentals may be made. With regard to colleges not so fortunate, trips can be extended to three days, covering a maximum of six inspections. If a plant employs a variety of processes, as in the case of a general chemical plant, a day may be very well spent on it alone. A continuous trip of more than three days is not advisable as the student becomes saturated with information and, in a good many cases, his physical stamina reaches so low an ebb that he is unable to get the best results from later inspections.

The type of plant visited should be that which offers as wide an application of chemical principles and machineries as possible. The industry should be one in which the flow of materials can be easily traced and one in which the operation of machinery is visible. This necessitates a knowledge, on the part of the instructor, of the plant visited and he should have this particular plant in his mind's eye when he lectures on that subject. The student will then see unfolded before him the process as he has visualized it.

In order to get this particular viewpoint, the instructor should visit the plant prior to the trip. He should develop the trip through the plant in a manner that will make the inspection of the greatest value to the student. The instructor should not merely indicate a furnace and state that it is a hearth furnace for the production of sulfur dioxide. He should give an idea of the furnace construction, capacity, method of heating and state whether it operates under oxidizing or reducing conditions, and how it is charged and discharged. Such elaborate discussion will bore some students, but it must be appreciated that inspection trips are for instruction and not for entertainment.

In most instances, the time spent in inspection trips is rather limited so that the plants visited should be considered with the utmost care with regard to the diversity of operations. The plants should be small, compact, and above all things, modern. A plant using a large number of chemical engineering fundamentals in its processes, is admirable for inspection. With these points in view, the following industries will

offer a wide choice from which an instructor can construct a well-balanced trip in almost any large industrial center.

By-Product Coke.—Illustrating transportation of gases, liquids, and solids; grinding, pulverizing, continuous retorting, condensing, crystallization, and distillation.

Cement.—Quarrying, conveying, grinding, pulverizing, continuous retorting, waste heat recovery, mixing, and stirring.

General Chemical Plant, Inorganic.—Acids, sulfuric (chamber and contact), hydrochloric, nitric, salts, and oxides. This comprises a study of tanks, stirrers, kneaders, mixers, hearth furnaces, crystallization, *in situ*, concentration, and solution.

General Chemical Plant, Organic.—Manufacturing dyes and intermediates. This comprises a study of nitrators, sulfonators, autoclaves, drying, filterpressing, volatile solvent recovery, distillation, and classification.

Sugar.—Clarifying, filterpressing, vacuum evaporation, decolorizing, centrifuging, drying, and packing.

Textiles.—Thread making, bleaching, printing, dyeing, and metal etching.

Added to the above list, the following industries give a partial insight into the applications of chemical processes and machineries: rubber, leather, soap, paint, petroleum refining, varnishes, and fertilizers.

When studying a plant, a student should take special care to observe the source of raw material, whether close at hand or subject to long haulage, and the market for the finished product; in short, the reason for the location of the plant in a particular region.

Within the plant itself, routing of material should be emphasized, and note made as to whether it is in a regular and orderly manner. The student should be taught to hunt for the reason of a particular scheme of movement.

When dealing with the finished product, the student should have some idea as to the quantity of material produced in unit time as well as the cost per unit of product. This, of course, necessitates a knowledge of the percentage yield.

A study of the plant itself should not be neglected. Such items as construction of plant, whether built for the purpose for which it is used or whether remodeled and adapted, are of prime importance in discussing the location of the different units of an operation and a flow-sheet of the material through them.

Without doubt, the greatest benefits derived from inspection trips are the views presented in the report that should be required of the student. From a student's report, the instructor can get an insight into his tendencies, and will have a foundation on which to base recommendations as to his aptitude for plant production, executive work, or research along purely scientific lines.

The phenomena are our data, and behind them we cannot go except in imagination.—A. SCHOPENHAUER

PRINTING INK

WOODFORD F. HARRISON, CALIFORNIA INK CO., WEST BERKELEY, CALIFORNIA

The word "ink" suggests to the majority of people a writing fluid. Few realize that the greater portion of ink used is consumed by various types of printing presses and that only a small fraction flows off the ends of pen points. Another wide-spread illusion is that any material with the name "ink" attached must be a water-like, colored fluid and may be diluted with water, but with printing inks this idea is entirely erroneous. Most printing inks consist principally of a suspended pigment or color in an oil which may vary all the way from an oily fluid to a sticky and viscous or plastic material.

The ink industry has developed with the printing press. The ink used with the old-time ink balls for printing with the antique presses that literally pressed the ink into the paper was entirely different from the modern product. Every printer used to make his own inks and on his own secret formulas which had been handed down and added to until they were frightfully complicated. The making of good ink was an art. Today the printing ink factories, with their laboratories and technical experts, are introducing simplicity and making a science of the industry.

W. F. HARRISON

Examine some of the finest printed process color work. It is almost perfect in every detail and is the artist's closest rival. The modern printing machines have made it possible, but the ink maker has done his part by producing inks with purer colors that work well under the most exacting conditions. The screen used for the reproduction of a photograph may be as fine as 400 lines to the inch, so that one can well imagine the state of division required of the ink pigments. In fact, the color particles are frequently fine enough to show the Brownian movement.

The old mineral colors, such as the umbers, siennas, and ochers, which were once so important to the ink maker can seldom be used with success now. Many new organic colors with excellent permanency and brightness have been developed, and these are far more satisfactory. A better black than carbon black, however, has never been

found although many improvements have been made in its physical properties.

In spite of pronounced differences between varieties of printing inks, they are nearly all similar in principle of make up. As stated before, they consist of a pigment or color suspended in an oily medium. The color is usually insoluble in both water and the oil in which it is suspended and may be either organic or inorganic. The binding material or vehicle, although nearly all oil, is supplemented with various gums, resins, waxes, and water-insoluble soaps.

It should be clear that the manufacture of printing ink is a subject involving the production and use of far too many chemicals to be more than briefly outlined in this very condensed treatise. There are few other single industries which involve more varied raw materials or so great a number of them. This condition makes of the subject a field of study almost without bounds. The ink maker thinks of the term "printing ink" as a very general one, conveying little meaning until it is further modified by terms such as "offset," "litho," or "news." It must, therefore, be borne in mind that we are not attempting to crowd enough information into these few pages to make it possible for the reader himself to make inks. A general understanding of the subject is the only aim.

Dry Colors

The characteristics of a good dry color depend upon the particular kind of ink in which it is to be used. For this reason colors are classified by means of a series of tests that are designated by color, strength, permanency, oil absorbtion, possible chemical reactions with other ingredients, printing qualities, and "bleed" (solubility) in water, in paraffin, in oil, and in dilute alcohol. These tests also serve to maintain uniformity of products simply by blending off standard batches in a way to correct their faults.

The hue is determined by comparing the overtone or mass tone and undertone against a selected standard dry color. Both standard and sample are ground with a spatula in linseed oil and smeared side by side on a glass slide, making small differences of mass tone detectable to a practiced eye. The undertone is obtained during the process of the strength test. This is accomplished by reducing both standard and sample ten times with zinc oxide and rubbing with oil on a glass slab and comparing on a glass slide. If either standard or sample shows stronger it is further reduced with zinc oxide until the two match. This makes it possible to note the difference in color when reduced with white and also state the strength in per cent stronger or weaker than standard.

The amount of oil necessary to wet a given weight of color is a measure of the oil absorbtion. Its variation is due to differences in physical struc-

ture of the pigment. Its consideration is important in order to maintain uniformity in the consistency of inks.

Permanence is absolutely necessary if an ink is to be exposed to much light, as in the case of posters and labels. It may be conveniently measured by the Fade-o-meter which employs a carbon arc for fading printed samples of an ink containing the color in question. This method is more satisfactory than the use of sunlight, since it is speedier and the source of light is constant.

Comparative determinations of the solubility of a color in water, dilute alkali, hot paraffin, or oil, are made in order to determine the class of work for which it may be used. For example, a color which bleeds badly (*i. e.*, which is soluble) in water is not good for a lithographic ink because it would color the bath and, therefore, tint the entire printed sheet. For a similar reason, printed work that is to be paraffin-coated must use an ink containing a paraffin-proof color. Soap wrappers must be printed with alkali-proof colors. (Alkali is more likely to cause fade than bleed.) Bleed in oil is dangerous. It may cause staining of the reverse side of the paper, or penetration into a color printed over it.

Aging of an ink sometimes causes it to thicken to a rubber-like consistency. This phenomenon is commonly known as "livering" and is due to reaction between pigment and oil to form soaps of the fatty acids present. These soaps are only colloidally soluble in linseed oil and form a sort of jelly structure. This difficulty can usually be overcome by controlling the method of dry color manufacture. Sometimes the fault may be in the oil used. Basic colors tend to "liver" much more than neutral colors. This is the most important of the many chemical reactions which can take place between pigments and other ingredients in an ink.

Of all the tests that can be applied to a dry color to determine its value in ink making, the actual grinding into an ink and trial on a press is the most convincing. The way the ink distributes on the rolls, lays on the paper, transfers from plate to paper, or dries may be partially or wholly due to the dry color. A color which has no natural affinity for the absorbtion of oil seldom prints well. By natural affinity is meant the chemical attraction of color for oil. For example, organic lake colors contain molecular groups which one would expect to dissolve in a hydrocarbon, and they probably do, by conveniently orienting the molecules at the surface of a color particle so that these groups can be actually dissolved in the oil. An example of the reverse type of pigment is barium sulfate which is hard to grind into a varnish and, wherever present in a large percentage, causes poor working qualities in an ink.

The actual manufacture of dry colors involves a broad field including organic, inorganic, and physical chemistry. It would seem a simple

matter to pour a solution of bichromate into lead acetate and obtain a chrome yellow and yet by variations of this procedure yellows may be obtained which are all the way from a light greenish, canary yellow to a deep red-orange. This is due to the tendency of lead to form basic salts and also to variations in particle size of the precipitate. This illustrates the complexities of color making. It is only by exceedingly careful control that the large group of mineral and organic colors used in printing ink can be maintained uniform in physical and chemical properties.

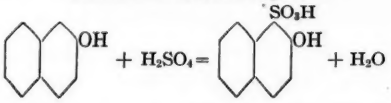
Almost all colors are precipitated on an inert white base such as aluminum hydroxide, barium sulfate, lead sulfate, calcium carbonate, or even insoluble soaps of rosin acids. This is not done to cheapen the product, but, rather, to improve its working qualities in inks. Aluminum hydroxide is more commonly used than the others because it is light in density, combines well with linseed varnishes and has a natural tendency to hold color or be actually dyed with organic colors. In many cases such procedure gives an increase in strength per unit of coloring matter used because the white base present causes precipitation of the color in smaller particles, increasing its power to color white material.

The general procedure for making dry colors is (1) preparation of solutions of chemicals to be used, (2) precipitation by running together in a tank, (3) filtering, (4) drying, and (5) grinding. It is useless to name or describe all of the many colors important to the ink maker, but a brief description of the production of a few important ones is of interest.

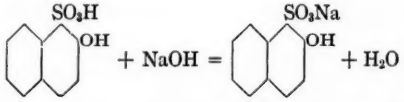
The ferric ferrocyanide compounds are the most important blues, giving quite a range of shades from a greenish undertone to a decided reddish or violet. Every manufacturer probably has his own pet procedure for obtaining certain shades of blue, but essentially the process is: sodium or potassium ferrocyanide plus ferrous solution to give the white precipitate, ferrous ferrocyanide, which is oxidized to the blue color (ferric ferrocyanide) by one of several oxidizing agents such as sodium bichromate, nitric acid, or chlorine. The above names given for the ferrocyanide compounds are not strictly correct because double salts of sodium, potassium, or ammonium ferrocyanide with ferric ferrocyanide are formed depending on which one is present. The potassium or ammonium will form at the expense of the sodium. The formulas of these compounds are so much in disagreement that it is hardly worthwhile giving them. The potassium and ammonium both give greener and brighter blues than sodium.

Lithol Red is one of the most permanent reds obtainable for use in printing inks. Its manufacture exemplifies the difficulties involved in producing uniform color lakes. Briefly, the process is as follows:

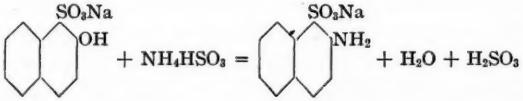
Sulfonation of Beta Naphthol



Temperature control is essential. The product thus obtained is salted out with strong caustic and filtered.

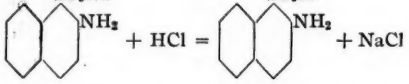


The next reaction of replacing the OH group by NH_2 is the most difficult to control. It is carried out in an autoclave equipped with cooling coils. Temperature control is again important.

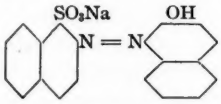


The product thus obtained is the sodium salt of 2-amino-1-naphthalene sulfonic acid and must be salted out of solution with NaCl and filtered. At this stage there is some beta naphthalene sulfonic acid which must be salted out of solution with NaCl and filtered. There is also some beta naphthylamine which has formed in spite of careful control and must be removed. If left in it will spoil the colors which are finally obtained. The beta naphthylamine is insoluble in cold water, but the desired product is not, which permits easy separation.

Finally, the sodium salt is changed to the acid which is known as Tobias acid, the intermediate for Lithol.



The Tobias acid is insoluble and may be filtered out. It is diazotized and coupled with beta naphthol to give Lithol, which is



Lithol is orange-red in color and insoluble in water, which permits it to be used in this form as a dry color, but a deeper, bluer red is obtained by changing the sodium atom for barium or a still deeper red if calcium is used. This process is known as laking and takes place when the sodium

salt of the dye is mixed with the laking solution such as barium or calcium chloride. Heat is usually necessary depending on the nature of the dye.

Lithol Red offers a greater series of colors than most dyes. The calcium and barium lakes are the most important, but they, within themselves, give a range of reds from a bright, slightly blue one to a very deep, dark one with a distinctly blue undertone. This wide variation is obtained by controlling the physical and probably chemical properties when making the lakes. Particle size and shape, though difficult to control, are of extreme importance, offering the greatest possibilities in the field of color making. Lithol lakes give even further possibilities through changes in procedure when making the intermediate and diazotizing and coupling. In such cases, the color changes are mainly due to the removal or introduction of impurities from side reactions.

Sometimes a dye itself is insoluble and can be used as a dry color. Paranitraniline, coupled with beta naphthol, and alkali blue (triphenyl-*p*-rosaniline and diphenyl-rosaniline sulfonated) are both examples of this. Then again a soluble basic dye, such as methyl violet, can sometimes be precipitated with an organic acid such as tannic acid, giving a rather fugitive but good strong violet. Finally, the most important of all pigments is carbon black which is used in almost all black inks.

The vehicle or varnish, which is to carry and hold the color in suspension, is of equal importance with the color itself. It contributes largely to the stickiness or "tack," length, flow, and drying properties of an ink, and these are important in controlling the ink to fit specified press, paper, and climatic conditions.

Ink varnishes are of two types—oxidizable (or drying) and non-oxidizable, being made from drying oils and mineral oils, respectively. Either of these may contain gums, resins, pitches, or asphalts, or a combination of them.

The chief oxidizable oils are linseed, soya bean, china wood, and perilla, the differing properties of which will not be discussed. The refined oils must have a low acid value, a light color and be fairly free of foots (colloidal matter which separates on aging). A high acid value oil will have a greater tendency to react with the pigments used with it.

The treatment of such oils is usually simply one of polymerization by heat in order to produce the right viscosity for the particular ink desired. Polymerization also stops the penetration of the oil into the paper. A complete series of ink varnishes thus prepared should be about five in number ranging in viscosity from 500 to 6000 seconds on the Universal Saybolt viscosimeter at 130°F. Gum resins such as Dammar or Kauri are sometimes added to produce gloss.

Varnishes are also prepared from mineral oils by dissolving gums, rosin or the glyceride of rosin, asphaltums, stearine pitch, and rosin oils

in them. Such cheap varnishes are used in inks for newspapers, burlap or cotton bags, etc., where drying is mainly by penetration of the vehicle. The rosin oils and asphaltum varnishes are used only in black ink because of their dark color.

The technology of varnish manufacture is too involved and, in fact, obscure a subject to treat briefly. If the endeavors of pure science had gone as deeply into colloid systems of hydrocarbons as into water systems, then varnish technology would be clearer. More rapid advancement is now being made, but a huge amount of research is to be done before the guessing stage is past.

In order to control the speed of oxidation or drying of inks, it is necessary to use driers. They consist mainly of either cobalt, manganese, or lead soaps of the oxidizable oil acids or rosin acids. The strength of these driers depends greatly on the way in which they are prepared. In general, if the soap is made by a fusion process and dissolved into the varnish it is a more powerful drier than if precipitated, dried, and ground into the varnish. The last method also tends to dry the ink with a flatter finish.

As has been repeatedly brought out, the manufacture of printing ink is far more than a mere combination of pigments, driers, and oils. The characteristics of these ingredients have been briefly considered from the standpoint of their effects in an ink, so that now the problem comes down to one of selecting ingredients that when properly combined make an ink suitable to give the best results.

"When properly combined" should be emphasized. The color is precipitated in very fine particles, but filter pressing and drying cause agglomeration to take place. Although the agglomerates are partially broken up by dry grinding to a fine dust, the original particle size is not obtained until the color is mixed with the vehicle and ground again. This second grinding is done on steel roller mills and, aside from breaking agglomerates, it replaces adsorbed air with the vehicle. Grinding is continued until there are no grains visible to the eye and this means that every individual particle is completely coated with a film of the varnish. Such a condition is essential if the ink is to distribute well on the press rollers and printing plate without dropping out some of the color.

When it comes to the final step of fitting the correct ink to a particular press, paper, and job, the procedure is quite specific for every different condition. For instance, an ink to be run on a web press (newspaper ink) must be quite thin and fluid. On the other hand, a soft news ink won't print at all on an offset lithographic press or for any job using hard finished paper.

The high-speed news press works with a cheap, soft paper stock requiring an ink that will dry by penetration. If a sticky, heavy-bodied

ink were used, it would pull lint from the soft paper which would fill in the fine work of the plates. For this reason, web press inks are made mainly from light mineral oils, color, and a small amount of a viscous varnish to hold the color in suspension.

Similar to news inks, there are inks for burlap and cotton bags, fruit-wrappers, etc., all of which require a rapidly penetrating vehicle. Many inks of this grade, however, contain some oxidizable varnish which hardens after some time so that the ink will not smear or rub.

Litho offset inks are directly opposite from news inks in characteristics. They must be able to resist the water used on the plates to prevent its blank portions from inking up and must dry by oxidation because the paper used does not permit much absorbtion. They must also distribute evenly in a thin film, printing with a strong color. These requirements are satisfied by the use of strong pigments ground in a polymerized linseed oil of about medium viscosity. Other ingredients are also necessary to satisfy certain specific job conditions. Small percentages of vaseline may be used to shorten the body and cut its stick or tack; waxes to aid in distribution; gum varnishes for gloss or many other chemicals such as solvents, fatty acids or oils to prevent troubles which are far too numerous to discuss.

The ordinary job press inks, including cylinder press inks, are not far different from those for lithography. They are weaker colors with variations in body and tack to suit the conditions.

There are many other kinds of inks which fall under the class of printing, but can't even be mentioned. Many of them are different from those already mentioned because of some particular requirement, such as bread-wrapper inks (paraffin proof), inks for glassene paper, tin foil, cellophane, cartons, posters, tracing paper, and wood printing. Aside from these specialties, there are other general classes among which are plate inks (engraving), mimeograph, stamping, stencil, hectograph, and protectograph inks. In fact, printing ink appears in some form on the covering of almost every commodity sold.

POPULAR PHARMACY

Encouraged by the stimulus which interest in chemistry has received from the publication of "Chemistry in Industry," "Creative Chemistry" and similar books, the American Pharmaceutical Association is considering the preparation of a volume to cover the pharmaceutical field. Thirteen chapter subjects and authors have been tentatively selected. The execution of the project and its cost will depend somewhat upon the potential market. As far as can be estimated at present, the book will contain about two hundred and fifty pages and sell at a price somewhere between two and three dollars. Inquiries and communications should be addressed to J. C. Krantz, Jr., Lombard & Greene Streets, Baltimore, Md.

SIMPLIFIED CALCULATIONS IN COLORIMETRY

ROBERT F. MCCRACKAN, EMANUEL PASSAMANECK, AND KATE E. HARMAN, MEDICAL COLLEGE OF VIRGINIA, RICHMOND, VA.

In colorimetric analyses, a reading on the known (K) and a reading on the unknown (U) have to be taken, whether the colorimeter be of the single plunger, the two plunger, or the dilution type. These readings become the terms of fractions used in obtaining factors that form a part of calculation formulas, K/U being used for plunger type colorimeters, and U/K for those of the dilution type. These ratios are constant throughout a comparison in a colorimeter, and since they are used as factors they may be represented by F in the expressions:

$$K/U = F, \text{ and } U/K = F$$

If any fixed value be assigned to K, then U will assume a corresponding value, and vice versa. As the analyst can choose which term he will make constant, and can choose any value within wide limits, it is evidently advantageous to choose a whole number, and one expressible by one significant figure, for the divisor, such as 8, 10, 20, or 30. By so doing he can make all division short. He should, therefore, set the unknown in applying a plunger type colorimeter, and get a reading for the known, and in applying the dilution type colorimeter, vice versa. In using 15 as a divisor, as one would be compelled to do in using a 15 mm. Bock-Benedict cell for the unknown, he could divide successively by 3 and 5, the factors of 15, and avoid long division, and a similar procedure could be followed with any other factorable number.

Most writers on colorimetry assume the use of the plunger type colorimeter for exact work, and they usually direct that the known be given a value, and that a reading for the unknown be made after the fields are matched. The number 20 is most often used for the known, and the readings for the unknown, made to one decimal place usually, give values that make long division necessary, and the factors obtained by the division usually have to be rounded off to prevent the use of figures to more than the third decimal place.

The Klett Mfg. Co. has copyrighted tables prepared by Benedict showing values rounded off to three decimal places for values of K/U when K is 15, and U is 6.0 to 29.9, and when K is 20, and U is 8.0 to 32.9. Mathews[1] includes tables from Hulton-Frankel in his latest text, showing creatinine and sugar percentages in blood for readings for the unknowns when the known is set at 20, and Falisi and Lawton[2] give tables for calculating creatinine, non-protein nitrogen, urea nitrogen, sugar, and uric acid for readings for the unknowns when the known is set at 20. All such tables could more easily be prepared for readings on the knowns

when the unknowns are set, and the ease with which calculations could be verified would make work less empirical.

We present a table showing all values for K/U and U/K when the divisor is made 20 and the dividend varies from 10.0 to 45.9. None of these factors are rounded off, yet only 50% of them require as many as three decimal places. They are absolutely exact, and all are obtained by short division making it possible for students and analysts to verify calculations with little loss of time and energy, a thing that the best pedagogy would seem to demand.

Where most accurate work is done with colorimeters reading to the second decimal place, the wisdom of having a divisor with one significant figure is still more apparent. With such instruments and the unknown set on 20, factors absolutely accurate to the fourth decimal place, from an arithmetical point of view, can be obtained, and only 50% of them need four decimals to express them. A table giving these factors would be just ten times as long as our three place table based on readings made to one place.

COLORIMETER TABLE

All values for $X/20$ are shown when X varies from 10.0 to 45.9.

In both the calculation formulas, Known/Unknown = F, and Unknown/Known = F, the dividend is represented by X, and the divisor by 20.

X is the dividend in K/U, and in U/K

X	$X/20$	X	$X/20$	X	$X/20$	X	$X/20$	X	$X/20$	X	$X/20$
10.0	0.500	12.4	0.620	14.8	0.740	17.2	0.860	19.6	0.980	22.0	1.100
10.1	0.505	12.5	0.625	14.9	0.745	17.3	0.865	19.7	0.985	22.1	1.105
10.2	0.510	12.6	0.630	15.0	0.750	17.4	0.870	19.8	0.990	22.2	1.110
10.3	0.515	12.7	0.635	15.1	0.755	17.5	0.875	19.9	0.995	22.3	1.115
10.4	0.520	12.8	0.640	15.2	0.760	17.6	0.880	20.0	1.000	22.4	1.120
10.5	0.525	12.9	0.645	15.3	0.765	17.7	0.885	20.1	1.005	22.5	1.125
10.6	0.530	13.0	0.650	15.4	0.770	17.8	0.890	20.2	1.010	22.6	1.130
10.7	0.535	13.1	0.655	15.5	0.775	17.9	0.895	20.3	1.015	22.7	1.135
10.8	0.540	13.2	0.660	15.6	0.780	18.0	0.900	20.4	1.020	22.8	1.140
10.9	0.545	13.3	0.665	15.7	0.785	18.1	0.905	20.5	1.025	22.9	1.145
11.0	0.550	13.4	0.670	15.8	0.790	18.2	0.910	20.6	1.030	23.0	1.150
11.1	0.555	13.5	0.675	15.9	0.795	18.3	0.915	20.7	1.035	23.1	1.155
11.2	0.560	13.6	0.680	16.0	0.800	18.4	0.920	20.8	1.040	23.2	1.160
11.3	0.565	13.7	0.685	16.1	0.805	18.5	0.925	20.9	1.045	23.3	1.165
11.4	0.570	13.8	0.690	16.2	0.810	18.6	0.930	21.0	1.050	23.4	1.170
11.5	0.575	13.9	0.695	16.3	0.815	18.7	0.935	21.1	1.055	23.5	1.175
11.6	0.580	14.0	0.700	16.4	0.820	18.8	0.940	21.2	1.060	23.6	1.180
11.7	0.585	14.1	0.705	16.5	0.825	18.9	0.945	21.3	1.065	23.7	1.185
11.8	0.590	14.2	0.710	16.6	0.830	19.0	0.950	21.4	1.070	23.8	1.190
11.9	0.595	14.3	0.715	16.7	0.835	19.1	0.955	21.5	1.075	23.9	1.195
12.0	0.600	14.4	0.720	16.8	0.840	19.2	0.960	21.6	1.080	24.0	1.200
12.1	0.605	14.5	0.725	16.9	0.845	19.3	0.965	21.7	1.085	24.1	1.205
12.2	0.610	14.6	0.730	17.0	0.850	19.4	0.970	21.8	1.090	24.2	1.210
12.3	0.615	14.7	0.735	17.1	0.855	19.5	0.975	21.9	1.095	24.3	1.215

COLORIMETER TABLE (*Concluded*)

X	X/20	X	X/20	X	X/20	X	X/20	X	X/20	X	X/20
24.4	1.220	28.0	1.400	31.6	1.580	35.2	1.760	38.8	1.940	42.4	2.120
24.5	1.225	28.1	1.405	31.7	1.585	35.3	1.765	38.9	1.945	42.5	2.125
24.6	1.230	28.2	1.410	31.8	1.590	35.4	1.770	39.0	1.950	42.6	2.130
24.7	1.235	28.3	1.415	31.9	1.595	35.5	1.775	39.1	1.955	42.7	2.135
24.8	1.240	28.4	1.420	32.0	1.600	35.6	1.780	39.2	1.960	42.8	2.140
24.9	1.245	28.5	1.425	32.1	1.605	35.7	1.785	39.3	1.965	42.9	2.145
25.0	1.250	28.6	1.430	32.2	1.610	35.8	1.790	39.4	1.970	43.0	2.150
25.1	1.255	28.7	1.435	32.3	1.615	35.9	1.795	39.5	1.975	43.1	2.155
25.2	1.260	28.8	1.440	32.4	1.620	36.0	1.800	39.6	1.980	43.2	2.160
25.3	1.265	28.9	1.445	32.5	1.625	36.1	1.805	39.7	1.985	43.3	2.165
25.4	1.270	29.0	1.450	32.6	1.630	36.2	1.810	39.8	1.990	43.4	2.170
25.5	1.275	29.1	1.455	32.7	1.635	36.3	1.815	39.9	1.995	43.5	2.175
25.6	1.280	29.2	1.460	32.8	1.640	36.4	1.820	40.0	2.000	43.6	2.180
25.7	1.285	29.3	1.465	32.9	1.645	36.5	1.825	40.1	2.005	43.7	2.185
25.8	1.290	29.4	1.470	33.0	1.650	36.6	1.830	40.2	2.010	43.8	2.190
25.9	1.295	29.5	1.475	33.1	1.655	36.7	1.835	40.3	2.015	43.9	2.195
26.0	1.300	29.6	1.480	33.2	1.660	36.8	1.840	40.4	2.020	44.0	2.200
26.1	1.305	29.7	1.485	33.3	1.665	36.9	1.845	40.5	2.025	44.1	2.205
26.2	1.310	29.8	1.490	33.4	1.670	37.0	1.850	40.6	2.030	44.2	2.210
26.3	1.315	29.9	1.495	33.5	1.675	37.1	1.855	40.7	2.035	44.3	2.215
26.4	1.320	30.0	1.500	33.6	1.680	37.2	1.860	40.8	2.040	44.4	2.220
26.5	1.325	30.1	1.505	33.7	1.685	37.3	1.865	40.9	2.045	44.5	2.225
26.6	1.330	30.2	1.510	33.8	1.690	37.4	1.870	41.0	2.050	44.6	2.230
26.7	1.335	30.3	1.515	33.9	1.695	37.5	1.875	41.1	2.055	44.7	2.235
26.8	1.340	30.4	1.520	34.0	1.700	37.6	1.880	41.2	2.060	44.8	2.240
26.9	1.345	30.5	1.525	34.1	1.705	37.7	1.885	41.3	2.065	44.9	2.245
27.0	1.350	30.6	1.530	34.2	1.710	37.8	1.890	41.4	2.070	45.0	2.250
27.1	1.355	30.7	1.535	34.3	1.715	37.9	1.895	41.5	2.075	45.1	2.255
27.2	1.360	30.8	1.540	34.4	1.720	38.0	1.900	41.6	2.080	45.2	2.260
27.3	1.365	30.9	1.545	34.5	1.725	38.1	1.905	41.7	2.085	45.3	2.265
27.4	1.370	31.0	1.550	34.6	1.730	38.2	1.910	41.8	2.090	45.4	2.270
27.5	1.375	31.1	1.555	34.7	1.735	38.3	1.915	41.9	2.095	45.5	2.275
27.6	1.380	31.2	1.560	34.8	1.740	38.4	1.920	42.0	2.100	45.6	2.280
27.7	1.385	31.3	1.565	34.9	1.745	38.5	1.925	42.1	2.105	45.7	2.285
27.8	1.390	31.4	1.570	35.0	1.750	38.6	1.930	42.2	2.110	45.8	2.290
27.9	1.395	31.5	1.575	35.1	1.755	38.7	1.935	42.3	2.115	45.9	2.295

BIBLIOGRAPHY

[1] Mathews, Albert P.: "Physiological Chemistry," William Wood & Co., New York, **1925,** fourth ed., pp. 1073 and 1074.

[2] Falisi, J. Vincent, and Lawton, Vera A.: "Tables for Blood Chemistry Calculations," *J. Lab. and Clin. Med.*, **9,** 566–71 (1924).

Folin, Otto: "A Laboratory Manual," D. Appleton & Co., New York, **1922.**

Myers, Victor C.: "Practical Chemical Analysis of Blood," C. V. Mosby Medical Book and Pub. Co., St. Louis, **1924.**

NOTE-BOOKS IN LABORATORY INSTRUCTION

W. G. BOWERS, COLORADO STATE TEACHERS' COLLEGE, GREELEY, COLORADO

In studying the results of Stubb's investigation,[1] with reference to recording laboratory notes in high-school chemistry, and recalling some past experiences along the same line, suggestions arose to the effect that some things might be said in behalf of some purposes of keeping laboratory notes, other than gathering information and fastening it in the mind.

Students often think that laboratory notes are just like text-book notes in that they outline in some cases, augment in other cases, and supplement in all cases. Students also are inclined to consider the laboratory note-book like the lecture note-book in that it is a brief record of facts in the order in which they come and that is all there is to it. The greatest mistake of all, however, is made in considering the laboratory notes like library reference notes—a gleaned and concentrated record of the important facts concerning a certain proposition. The whole purpose of notes seems, to students and sometimes to teachers, to be to gather information and fasten it in the mind.

If notes are ever taken on text-book work, they do not call for original thinking on the part of the student, unless they call for a selection of important facts or a discrimination among significant and insignificant items. Here the author of the text has done the organizing. Lecture notes really call for no originality on the part of the student. Here the lecturer has done the organizing. Library reference notes may or may not call for much original thinking. This depends largely on the project on which work is being done. In certain cases there is need of selection and discrimination as notes are taken and also thoughts as to the plans concerning the application of the notes, the fitness of certain notes to certain places in the plan.

In the organization of notes exists, to a great extent, the problem phase of chemistry. The mere recording of the facts concerned with an experiment like the mixing of iron filings and sulfur and separating the elements by means of a magnet and some carbon disulfide and the heating of the elements and the subsequent efforts to separate them, etc., must not be interpreted as aids to the memory or something that can be referred to, which will tell us how these two elements may be separated or what conditions will bring about a permanent combination. But these notes must be organized so that they will lead to an unmistakable conclusion as to what a mechanical mixture is and what a chemical compound is, etc.

Without a definite plan as to the organization of notes, without knowing the purpose of the experiment and taking careful notes on it, without having any idea as to the conclusion to be drawn from the experiment,

[1] THIS JOURNAL, 3, 296–300 (1926).

the student is very liable to make mistakes and not know that they are mistakes. With a definite idea as to the organization of notes, with a knowledge of a logical relation to be found in occurrences, the student will know better what is a successful and an unsuccessful effort. Under all circumstances, no matter how much time is required, the student should record unsuccessful efforts and speculations as to the cause of errors.

I. J. Mathews[2] says, "Do not require note-books to keep the students busy." He contends that in our note-book work we require too much writing and not enough of working. We should say that such pedagogy might apply to advanced students—students who have received certain training in relating the purposes, observations, and conclusions of laboratory experiments. There does come a time in the chemist's training where the extensive organized notes may be left off. This does not depend so much upon the time element or the number of experiments done as it does upon the character of the work engaged in.

One preparing to become a researeh chemist can ill afford to ever make brief notes. The one preparing for a teacher is in the same situation. The one preparing for a routine assistant in a well-organized laboratory or for a government civil service position perhaps, is the only one who might be justified in filling blank spaces in printed notes.

Teachers of almost any subject will advocate notes. History teachers say they aid the memory. That might be said to be one of the least significant purposes in the laboratory. Another better reason is, they furnish the student a record of his own work, results of his own efforts, something to refer to which tells a story as it could be told in no other way. But the greatest reason of all is, the beginning student needs a visible answer, formulated in his own words, to the ever recurring question, what and how much must I get out of this? And generally his original thinking begins only after he begins to express these answers in black and white.

John L. Dahl[3] says, "note-books are good to develop systematic habits, to avoid slip-shod work as to punctuality, to cultivate orderliness, and to help coöperate with the English teacher in the matters of spelling, composition, etc." Dahl then recommends printed directions. He undoubtedly means the mere directions and not printed sheets with blanks to fill in. He, at the same time, recommends careful organization and calculation.

In our own experience we have found it necessary to carry out ideas like these in order to get creditable results. This is the reason why we so strongly advocate temporary notes followed by permanent, well gotten up, and thoroughly complete ones.

[2] *Sch. Sci. Math.*, **16**, 767 (1916).
[3] *Ibid.*, **18**, 712 (1918).

B. S. Hopkins,[4] in his suggestions regarding the conduct of laboratory work, reminds us of the importance of promptly reviewing work as noted by the student. It might be agreed that this had best be done before the conclusions go into any sort of notes. But if twenty or thirty people are completing an experiment at about the same time, and we desire them to use their own originality first in formulating conclusions time will not permit us to give them individual help. The best we can do is to let them exercise their originality on a temporary sheet which can be taken and criticized by the instructor and handed back to the student while the experiment is still fresh in his mind. Then the student is more willing and more able to correct errors. Then, too, at the end of the course the instructor has only to see that the student has a permanent note-book in which he has corrected the mistakes.

J. Norman Taylor[5] says, "records must be immediate, reliable, adequate, and permanent." It would seem to us that the only way in which all of this could be accomplished would be by two sets of notes. Temporary notes taken after each step in the procedure would guarantee reliability. Of course these would have to be adequate enough to get in all truths, but they could be meager as far as English composition and scientific expression is concerned. Then the permanent ones should follow without any more intervening time than necessary. These should be more adequate in order to make everything clear to one after the details of the experiment might be forgotten. These are the only notes that can be of any value as permanent notes.

Percy E. Rowell[6] says, "one value in note-book work is often overlooked, that is, the opportunity for organized self expression." Of course, we would agree with him and say that the note-book is of no value unless a definite record of a definite observation is made in such a way as to leave a definite and lasting impression. We would say with Rowell too that the student should not stop with notes as to the investigation as the investigator does, but the student should write up his notes. Rowell's form we think would be a little too meager. We agree with Rowell most heartily, when he says that a science note-book is a great factor in education if it is a means to an end. If it is an end in itself, it is a piece of hypocrisy; in his own words, "as a tool it is priceless, as a product it is worthless."

It is with these ideas in mind that we condemn the type of note-book which is printed in every way excepting blank spaces for figures, etc. We would even advocate less laboratory work, if necessary, to give the student sufficient time to organize and get a note-book in good form.

[4] *Sch. Sci. Math.*, **19**, 295 (1919).
[5] *Ibid.*, **21**, 826 (1921).
[6] *Ibid.*, **19**, 525 (1919).

For each heading, the student should have a definite idea of what to note. For purpose, he should have in mind a real objective. In order to get this idea he should read through the entire set of directions, and formulate a statement of the purpose which will cover all phases of the experiment.

Keeping a list of the apparatus and materials helps the student in two ways. It aids him in setting up the apparatus and materials in such a way that the work is facilitated and it helps him familiarize himself with names and formulas of compounds and pieces of apparatus.

The method of procedure need not be rewritten nor even noted if it is carried out exactly as directed.

It is easy to perceive, as Stubbs has proven, that it would be a waste of time in most cases to record what was done. Here again the student merely copies without taking time to think. The surprise regarding this kind of note-book work is that Stubbs found that it aided the memory for a few days.

If the manual is the best type of manual it does not contain the details which should be reasoned out by the student. In this case the student should note those details with the reason for them. Any good directions will leave question marks after certain parts in order to call forth from the student thoughts as to the reason for the procedure. The answers to these questions should, of course, be noted. Questions regarding what is observed should be answered under the heading of observation. If for any reason directions should be varied, of course the variations should be carefully noted.

In many cases good manuals do not picture the train of apparatus. To do this would make a manual very expensive, and it would also deprive the student of the opportunity of solving certain problems which he should think out. However, the student should illustrate in his notebook in as scientific (not necessarily artistic) a manner as possible the arrangement of the apparatus as set up ready for operation. Indications of what materials go into what parts of the apparatus should be specific. Parts of the apparatus should be accurately labeled as to the function of each part in the process. This pertains, of course, to the student's notes after the experiment has been performed and the proper results obtained.

The observations play a very important role in the student's part of the laboratory work. They should be very carefully noted and accurately recorded all under a heading separate from that of the directions, especially in the permanent notes. Temporary notes may have an observation following each step in the procedure, but if this plan is carried through the permanent organization of the notes, the student is too liable to lose track of some important occurrences. Putting all of the obser-

vations under a separate heading also tends to cause the student to relate the occurrences to each other in a logical way. This has greater force in leading through scientific thinking to proper conclusions.

If occurrences are as they ought to be and are fully and accurately recorded, formulated conclusions would not necessarily go into the temporary notes. Rather with all of the facts in mind, the student can go to his private room and be in a better frame of mind to formulate conclusions. This should not be interpreted to mean that the instructor would have no chance to help the student on his conclusions. In fact this is the part on which the student needs most help at first.

The beginner is inclined to make his conclusions too narrow. That is, he does not make them to cover laws or principles or fundamentals of any kind. For example, he concludes that iron and sulfur can be separated by means of a magnet, instead of concluding that a mixture can be separated by mechanical means. The student should be encouraged to relate conclusions to the objective of the experiment as it is expressed in the manual. For example, in the experiment referred to above, if the objective is to study the properties of iron, the student would be justified in expressing the conclusion that iron can be separated from sulfur by means of a magnet. But since the objective is to obtain a practical method of distinguishing between a mixture and a compound and learn the fundamental differences, the proper conclusion is to be more general, and expressed as if applied to mixtures and compounds in general.

The question concerning mathematical problems connected with elementary chemistry is always a vital one. We shall not insist on settling the whole problem in this relation. We do believe, however, that most practical problems and some fundamental ones more properly belong in connection with the laboratory work and should be solved there and the methods of solution recorded in the laboratory note-book. Of course, not all calculations in detail need to go into the notes. Formulas, substitutions therein, and indications of processes with final results are all that are necessary. As to the place in the note, this depends on the place in the experiment. If the problem is in connection with the preparation of materials, its solution should go with methods of procedure. If it comes as a result of the experiment it should be written up in the conclusion.

As to the writing of equations, we would have to say that, according to the plan of most good text-books and manuals nowadays, we could not expect the student to do any of this sort of work during the first quarter or semester. But from that time on the student should, with as much independence as possible, work out balanced equations for all reactions taking place in the processes involved in the experiment undertaken. The student's best efforts at these (not excluding references

to best authorities available), should go in with the temporary notes for correction by the instructor, before permanent notes are made. Their place in the permanent notes should correspond to their place in the directions.

As to the frequency of grading or checking over notes most instructors will readily realize that the more often this is done the better it is for the student. Out of 162 answers from the high schools of the North Central Association as to the frequency of note-book grading, we found that in 74 high schools the notes were graded every day. In 34 they were graded every week. In 17 they were graded irregularly. In 35 they were graded every quarter or semester. In two schools the instructor graded the notes everyday for the first few days and then less frequently. Of the 17 irregularities, in one school the instructor took out the notes on one experiment every six weeks, not letting the student know which one was taken out, and that was the only one graded. In one school only did they require two sets of notes, temporary and permanent. Out of the seventeen irregularities also should come eight schools in which the notes were graded every three to six weeks. The majority of the schools which reported infrequent grading of notes were large schools having large chemistry classes. In seven cases, footnotes were given to the effect that it was impossible, on account of the large classes, to grade notes each day. It can be easily inferred, however, from the above data that the majority of instructors realize the importance of frequently grading notes.

Many instructors advocate the frequent inspection of students' notes with the idea that it avoids piling up work on the teacher at the last of the quarter or period of work. We would not discount this, but if there is any point to giving time to the students' notes, the student should have the benefit of this time before it is too late.

The student having the benefit of the corrections will be more liable to get the desired training in laboratory procedure even though he has had very careful supervision in his work as it progressed. The greatest benefit, however, is in the training of the student in the organization of his note material, so as to cultivate scientific thinking and the expression of scientific thoughts.

Grapes Have Measles; Promising Cure Found. An epidemic of measles has been afflicting California grapevines, and a new remedy is put forward by L. O. Bonnet of the California Agricultural Experiment Station. The disease is the same as the affliction of the vine known in France as "apoplexy," though it has no relation to either measles or apoplexy in human beings. It makes dead patches in the leaves, and then kills off whole shoots and ruins the fruit, working from the top of the vine downward. Mr. Bonnet has found that spraying the vines with four or six per cent sodium arsenite solution will prevent the development of the disease.—*Science Service*

APPLICATIONS OF MODERN VALENCE THEORIES TO SOME INORGANIC CHEMICAL REACTIONS

MARY A. GRIGGS AND MARION E. WARNER, WELLESLEY COLLEGE, WELLESLEY, MASS.

The object of this study is to find, with the help of recent theories of valence, satisfactory explanations of the mechanism of some of the oxidation and reduction reactions of inorganic chemistry—especially those in which peroxides and polysulfides take part. These have not been satisfactorily explained by the older theories.

To chemists the theories of the structure of the atom and the resulting theories of valence are only satisfactory when they explain adequately the chemical as well as the physical properties of the elements and compounds, and their reactions.

Theories of Atomic Structure

The recent theories of the structure of the atom as presented by Rutherford, Bohr, Lewis, and Langmuir have all assumed a positive atomic nucleus with electrons arranged about the nucleus. The positive charge on the nucleus is equal to the number of electrons and these quantities both vary from 1 in the hydrogen atom through all the known and a few unknown atoms to 92 in the uranium atom. It is in regard to the arrangement of the electrons around the nucleus that the above theories differ. Lewis[1] and Langmuir[2] have both conceived of the electrons arranged in concentric shells about the nucleus in relatively fixed positions, for which the usual laws of electrical attraction and repulsion do not hold. On the other hand, Rutherford[3] and Bohr[4] assumed orbital motion for the electrons which were arranged in successive rings and were subject to the same laws of force as a planetary system. Bohr,[5] however, has recently assigned to each electron its own orbit in one of the shells about the nucleus, making the atom relatively static and more in agreement with chemical phenomena.

Valence Theories

It is generally agreed that the so-called valence electrons are in the outermost shell which never consists of more than eight electrons with the possibility, according to Lewis,[6] of a secondary valence shell. There is wide divergence of opinion as to just the part played by these valence

[1] *J. A. C. S.*, **38,** 762 (1916).

[2] *Ibid.*, **41,** 868 (1919).

[3] *Phil. Mag.*, **21,** 669 (1911); "Radioactive Substances and Their Radiations," G. P. Putnam's Sons, New York, **1913,** p. 619.

[4] *Phil. Mag.*, **26,** 1 and 857 (1913).

[5] *Nature*, **107,** 104 (1921).

[6] "Valence and the Structure of Atoms and Molecules," Chemical Catalog Co., New York, **1923,** p. 102.

electrons in chemical combination. Thomson[7] suggested what is known as the modern dualistic theory; that a valency bond between two atoms is due to the transference of an electron from one atom which is, therefore, left positively charged to the other atom which, therefore, becomes negatively charged and that chemical action is due to this transference of electrons. Falk and Nelson,[8] Fry,[9] Briggs,[10] and Stieglitz[11] have found this idea of value in developing an electronic theory of valence which they have used with some success in the explanation not only of inorganic but also of organic reactions.

On the other hand, the outstanding feature of the theory of valence presented by Lewis[12] and also by Kossel[13] is that the atoms in a molecule are held together by groups of electrons, which are shared by two atoms. According to Lewis, these groups are usually pairs and a pair represents one chemical bond. This idea has been extended and developed by Langmuir,[14] while Eastman[15] and Huggins,[16] and Kermack and Robinson[17] have recently made interesting additions to it.

Lewis[18] and Bray and Branch[19] early made a distinction between polar and non-polar compounds—*i. e.*, between polar molecules, in which each atom exists in a definite oxidation-reduction stage which according to Thomson's valence theory is due to a complete transfer of electrons, and the non-polar molecules in which the atoms may share electrons with other atoms and in which there is little or no displacement of electrons, according to the Lewis valence theory. Probably most compounds are not wholly of either type, but the inorganic compounds, which ionize in solution, are most highly polarized while most organic compounds are less or very slightly polarized. In any compound there may be an equilibrium between the completely polarized molecules and those which are less polarized, similar to the equilibrium between ionized and non-ionized molecules in the solution of an electrolyte.

[7] "The Corpuscular Theory of Matter," Chas. Scribner's Sons, New York, **1907**, p. 124.

[8] *J. A. C. S.*, **32**, 1637 (1910).

[9] *Z. physik. Chem.*, **76**, 385 (1911); "The Electronic Conception of Valence and the Constitution of Benzene," Longmans, Green & Co., New York, **1921**.

[10] *J. Chem. Soc.*, **115**, 278 (1919).

[11] *J. A. C. S.*, **41**, 868 (1919).

[12] *Ibid.*, **38**, 762 (1916).

[13] *Ann. der Phys.*, **49**, 229 (1916).

[14] *Loc. cit.* and *J. A. C. S.*, **41**, 1543 (1919); *J. A. C. S.*, **42**, 274 (1920); *J. I. E. C.*, **12**, 386 (1920).

[15] *J. A. C. S.*, **44**, 438 (1922).

[16] *Ibid.*, **44**, 1607 (1922).

[17] *J. Chem. Soc.*, **121**, 421 (1922).

[18] *J. A. C. S.*, **35**, 1448 (1913).

[19] *Ibid.*, **35**, 1440 (1913).

Reconciliation of Polar and Non-Polar Views

Lewis[20] in his recent book shows that it is not necessary to assume two types of chemical union to account for the difference between the polar and non-polar substances. "The pair of electrons which constitutes the bond may lie between two atomic centers in such a position that there is no electric polarization, or it may be shifted toward one or the other atom in order to give to that atom a negative, and consequently to the other atom a positive charge." This explanation of chemical bonds seems satisfactory from the point of view of both organic and inorganic chemistry as does also Lewis's new definition of valence[21]—the valence of an atom in any molecule is the number of electron pairs which it shares with other atoms. When, however, structural formulas for compounds like phosphoric and sulfuric acids are written from the octet standpoint and this definition of valence is applied, the results are far from clear.

As can be seen from these formulas the valence of *both* phosphorus and sulfur would be four while the atomic kernels have, respectively, five and six positive charges; in other words they have five and six valence electrons. Also, although the hydrogen atoms may not be permanently attached to particular oxygen atoms, at any given instant some oxygen atoms would have a valence of two while others would have a valence of one, for which no reason appears in the formulas. Possibly the difficulty of this configuration lies in the fact that it shows only the four outer electron pairs and does not attempt to take into consideration the charge on the kernel which is a real electrical quantity. There may be some relation between this charge which is, of course, equal to the number of valence electrons in the atoms, and the unshared electron pairs but it is not obvious.

Some Applications of the Dualistic Theory

Since it is the polar compounds which we are to consider in this study, we can use most satisfactorily the dualistic theory. The transfer of the electrons assumed in this theory does adequately explain not only the structure of the compounds themselves, but also the oxidation and reduction reactions of such compounds as are of fundamental importance. We have, therefore, used this idea with a configuration similar to that used by Fry in depicting electronic changes in certain reactions. Each minus

[20] "Valence and the Structure of Atoms and Molecules," Chemical Catalog Co., New York, 1923, p. 83.

[21] *Ibid.*, p. 104.

sign attached to the symbol of an element, means that the atom has received an electron, while the plus sign means that the atom has lost an electron.

Peroxide Reactions

The first group of reactions to be considered are those in which peroxides take part. It is possible to explain by this theory quite clearly the difference in the mode of linkage of the two oxygen atoms in peroxides as well as both the oxidizing and reducing reactions in which they may take part.

Sodium oxide, Na_2O, or written electronically $\begin{matrix}Na^{+-}\\Na^{+-}\end{matrix}O$ can be made to take on a second oxygen atom, forming sodium peroxide, Na_2O_2, which is a well-known oxidizing agent. This sodium peroxide may be given the electronic formula $\begin{matrix}Na^{+-}O\\ \dagger\\ Na^{+-}O\end{matrix}$. That is, the second oxygen atom probably shares with a sodium atom one electron pair which is almost completely shifted towards the oxygen atom, while the pair which it shares with the first oxygen atom is largely shifted toward that atom. Or we might say that the sodium atom gives one electron to this second oxygen atom which in turn gives one to the first oxygen atom in the molecule. We can, therefore, write this oxygen atom, $O^{\pm}$, which is an unstable form. The tendency of all such atoms in any peroxide would be to acquire two more electrons which would give it its most stable form in compounds, $O^{=}$.

Sodium peroxide oxidizes sodium chromite in solution to sodium chromate according to the equations:

$$2NaCrO_2 + 3Na_2O_2 \longrightarrow 2Na_2CrO_4 + 2Na_2O$$
$$2Na_2O + 2H_2O \longrightarrow 4NaOH$$

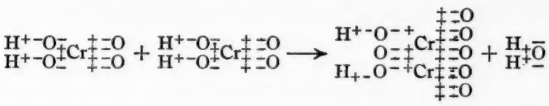
The reaction may be represented electronically as follows:

$$2\overset{+}{Na}{-}O{-}{+}Cr^{\ddagger=}O + 3\begin{matrix}Na^{+-}O_{\pm}\\Na^{+-}O^{-}\end{matrix} \longrightarrow 2\begin{matrix}Na^{+-}O^{-}_{\pm}Cr^{\ddagger=}O\\Na^{+-}O^{-}_{\pm}{}^{\ddagger=}O\end{matrix} + 2\begin{matrix}Na^{\pm}\\Na^{\mp}\end{matrix}O$$

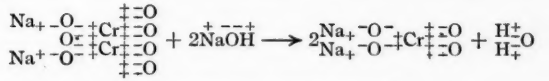
Each of the three oxygen atoms, $O^{\pm}$, has a tendency to take on two more electrons to become $O^{=}$. These six electrons are easily given up by the two chromium atoms, Cr^{+++}, so that they become Cr^{++++++}, a more stable form. Simultaneously with this transfer of electrons, there must, of course, be such a rearrangement of atoms in the molecules as will satisfy these oppositely charged parts.

On the other hand, when sodium chromate reacts with an acid to form the dichromate, there is no transfer of electrons.

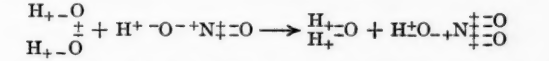
$$2\begin{matrix}Na^{+-}O^{-}_{\pm}Cr^{\ddagger=}O\\Na^{+-}O^{-}_{\pm}{}^{\ddagger=}O\end{matrix} + 4\overset{+}{H}\overset{-}{Cl} \longrightarrow 2\begin{matrix}H^{+-}O^{-}\overset{+}{}Cr^{\ddagger=}O\\H^{+-}O^{-}{}^{+}{}^{\ddagger=}O\end{matrix} + 4Na^{+-}Cl$$



That is, an intermediate weak acid is formed by the action of the strong acid and two molecules of this combine with the splitting off of a molecule of water to form another weak acid. The sodium salt of this is the product we get on crystallization. Likewise when a dichromate reacts with a base to form the chromate there is no transfer of electrons.

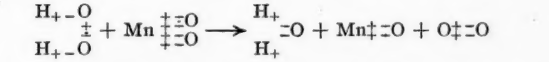


Hydrogen peroxide is another common oxidizing agent and it may also react as a reducing agent. Nitrous acid is oxidized by hydrogen peroxide according to the following electronic formula:



The nitrogen atom which is holding two more electrons than in its most stable condition in HNO_3, readily gives them up to the unstable oxygen atom $^{+}O^{-}$ of the hydrogen peroxide. This leaves the oxygen atom with a double negative charge which is its most stable form in combination and the nitrogen atom now has an excess of two more positive charges or five positive charges in all (its most stable condition). The doubly charged negative oxygen atom then satisfies its charges by uniting with the two excess positive charges of the nitrogen and the molecule formed is nitric acid, HNO_3.

The reduction reactions of hydrogen peroxide take place with the evolution of oxygen from both the peroxide and the compound to be reduced. The reduction of manganese dioxide with hydrogen peroxide follows this equation: $MnO_2 + H_2O_2 \longrightarrow MnO + H_2O + O_2$, or written electronically:



The presence of an acid such as nitric acid gives a salt of manganese, such as manganese nitrate. $MnO + 2HNO_3 \longrightarrow Mn(NO_3)_2 + H_2O$.

The second oxygen atom of the hydrogen peroxide, $O^{\pm}$, must in this reaction lose two more electrons becoming $O^{\ddagger}$, that is, oxygen with two positive charges. These electrons are taken up by the manganese atom which thus has two of its positive charges neutralized and is left with

two instead of four charges. The $O^{\ddagger}$ can then combine with the $O^{=}$ from the manganese dioxide to form O_2 that is $O^{=}{\ddagger}O$.

Polysulfide Reactions

The other group of reactions to be studied are those in which polysulfides take part. The structure of sodium polysulfide, Na_2S_2 may be written $Na^{+}{-}S^{+}$ / $Na^{+}{-}S^{-}$ and explained just as we have already explained the structure of sodium peroxide. The tendency of the sulfur atoms which have the charges $S^{\pm}$, is to take on two electrons, becoming doubly negative $S^{=}$.

Stannous sulfide is oxidized by sodium polysulfide according to the following electronic equation:

$$\begin{matrix} Na_{+}{-}S^{-} \\ Na_{+}{-}S^{+} \end{matrix} + Sn{\ddagger}{=}S \longrightarrow \begin{matrix} Na_{+}{-}S \\ Na_{+}{-} \end{matrix} + Sn\begin{matrix} \ddagger{=}S \\ \ddagger{=}S \end{matrix}$$

Since tin in its most stable conditjon has four positive charges, the unstable sulfur atom which tends to acquire two electrons takes them from the stannous tin leaving it with four positive charges. Then the sulfur which has necessarily broken from the polysulfide molecule becomes attached to the now stannic tin atom, giving a molecule of stannic sulfide.

Sodium sulfide dissolves stannic sulfide with the formation of the soluble sodium sulfostannate.

$$\begin{matrix} Na_{+}{-}S \\ Na_{+}{-} \end{matrix} + Sn\begin{matrix} \ddagger{=}S \\ \ddagger{=}S \end{matrix} \longrightarrow Sn\begin{matrix} \ddagger{-}S^{-}{+}Na \\ \ddagger{=}S \\ \ddagger{-}S^{-}{+}Na \end{matrix}$$

The stannic sulfide ionizing to give stannic ion, Sn^{++++}, and two sulfur ions, $S^{=}$, unites with the ionized sodium sulfide as shown above, two sulfur atoms extending one electron each, to each sodium ion. This shows how the sodium sulfostannate molecule ionizes to give 2 Na^{+} and SnS_3^{--} ions.

Acidification results in the formation of sulfostannic acid which is very unstable, breaking down easily into the insoluble stannic sulfide and the volatile hydrogen sulfide.

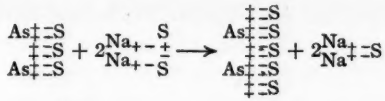
$$Sn\begin{matrix} \ddagger{-}S^{-}{+}Na \\ \ddagger{=}S \\ \ddagger{-}S^{-}{+}Na \end{matrix} + 2H_{+}{-}Cl \longrightarrow Sn\begin{matrix} \ddagger{-}S^{-}{+}H \\ \ddagger{=}S \\ \ddagger{-}S^{-}{+}H \end{matrix} + 2Na^{+}{-}Cl$$

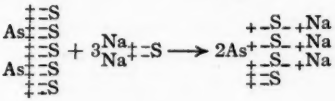
$$Sn\begin{matrix} \ddagger{-}S^{-}{+}H \\ \ddagger{=}S \\ \ddagger{-}S^{-}{+}H \end{matrix} \longrightarrow Sn\begin{matrix} \ddagger{=}S \\ \ddagger{=}S \end{matrix} + \begin{matrix} H^{+} \\ H^{+} \end{matrix}{=}S$$

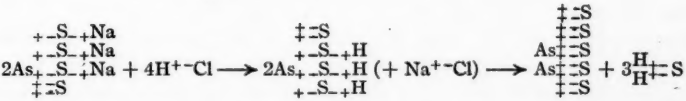
Arsenious sulfide, As_2S_3, reacts in the same way as stannous sulfide according to the equations:

$$As_2S_3 + 2Na_2S_2 \longrightarrow As_2S_5 + 2Na_2S$$

$$As_2S_5 + 3Na_2S \longrightarrow 2Na_3AsS_4$$



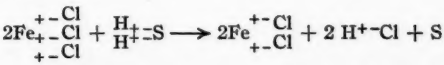




While the polysulfides do not act as reducing agents as the peroxides do, the simple sulfides can reduce many other atoms because of the tendency of the sulfur atoms S^{--} to lose two electrons and become free sulfur. An illustration of the reducing action of a sulfide is that of hydrogen sulfide upon ferric chloride in acid solution.

$$2FeCl_3 + H_2S \longrightarrow 2FeCl_2 + 2HCl + S$$

The electronic equation is:



The sulfur here tends to lose its two electrons and become free sulfur, which is precipitated from the solution. Each of two atoms of ferric iron gains one of these electrons given up by the sulfur and becomes ferrous iron. By the precipitation of the sulfur from solution a reversible reaction is prevented and the ferric iron can be completely reduced to ferrous iron.

Polarized Light Speeds Growth of Bacteria. Germs grow faster when they get their light arranged in a certain way, according to the results of the investigations of two Indian scientists, S. S. Bhatnagar and R. B. Lal, of the University of the Panjab, Lahore, who have just reported to the scientific journal, *Nature*.

The two experimenters took cultures of the germs of typhoid fever and cholera, and exposed one set to ordinary light, while the second set was placed under a beam of polarized light. Polarized light differs from ordinary illumination in that the fronts of the light waves are all arranged in the same direction, while in ordinary light they criss-cross at all angles. The germs seemed to thrive much better on polarized than on ordinary light.

Scientists have been much interested lately in the effects of polarized light on living things, since discoveries made by Dr. Elizabeth S. Semmens of Bedford College, London, indicate that the digestion of starch takes place more rapidly under its influence.—*Science Service*

LACQUERS AS PROTECTIVE COATINGS*

ARTHUR ORR, COMMERCIAL SOLVENTS CORPORATION, TERRE HAUTE, INDIANA

The subject that has been assigned to me suggests some preliminary questions. The phrase "protective coating" has been used for the last few years as a general synonym for paint, varnish, enamel, and similar coverings. But what is really a protective coating? What may it protect? What is the attacking agency against which protection is needed?

In nature we find that nearly everything has a protective coating. The bark of a tree, the husk surrounding an ear of corn, an onion-skin, pea-pod, banana peel, and the shell of a walnut are all different, but admirably designed, protective coatings. In the animal kingdom, we find an equal or greater variety. What could be more ingenious for their special purposes than the lobster's shell, the scales of a fish, and perhaps most wonderful of all, the skins of mammals?

There is a tendency to assume that a protective coating acts only in the interest of the object to which it is attached; that outside agencies, both physical and chemical, are destructive *per se*, and that a barrier must be put in their way which will check their ravages. This is often the case, but I hope to be able to convince you that other considerations are always involved and in some cases predominant; that a protective coating may even be a benefit to the observer or to some outside agency, as well as to the object on which it occurs. I would also point out that occasionally protection is needed against internal enemies, that, in fact, under some conditions outside agencies may be beneficial rather than destructive.

In any event, we must bear in mind that a protective coating may render a great variety of benefits in a great variety of ways.

Naturalists speak of protective coloring in plants and animals. This kind of a protective coating carries us beyond the mere establishment of a physical barrier. It involves design and color. The beauty which we may see in the skin of some rare fish, in the plumage of a brilliant bird, or in the marking of a leopard's skin, is not accidental. The evolution of these designs and colors is no doubt connected with the idea of protection. In some cases this may mean protection against destruction by a more powerful animal through relative invisibility; in other cases, protection against extinction through inability to attract. Emphasized visibility and beauty, in this instance, distinguished the individual fittest to survive.

It is evident that the laws of esthetics have their foundation in Nature, that these laws have a profound bearing on the color and design of natural protective coatings, and that man's use of artificial coatings is also influenced largely by esthetic as well as physical and chemical considerations.

The earliest use of pigments by man was, in fact, prompted solely by

* Address before Group 2—Students' Course, Tenth Exposition of Chemical Industries, New York, October 2, 1925.

his desire to make designs and drawings, and not by any intention to protect physically the surfaces on which these materials were applied. I think it is safe to say that the principal function of so-called protective coatings applied by man has, up to about the last century, been decorative rather than physically protective. A culture or civilization whose habitations and miscellaneous equipment are made of stone or earth obviously has little need for the purely protective properties of paint. Even today, if our sole object were merely to obtain maximum physical protection of underlying surfaces, our houses, our cities, and even our countryside would present a dreary aspect indeed, as we would have little use for other than black pigments. I will not press the point farther as I feel you must agree that the decorative or esthetic value of a protective coating plays a very large part in the development and use of man-applied materials, and when I deal in the rest of my talk principally with the physical and chemical aspects of lacquer as a protective coating, I will assume that its merit from an esthetic point of view is not forgotten in spite of the fact that we have no accepted units by which this most important characteristic can be measured.

Nitrocellulose lacquers are applied under ordinary conditions of temperature, pressure, and humidity. I will, therefore, in any comparisons refer only to materials similarly applied and will exclude those which require special conditions in connection with their application.

The following is a rough outline of the considerations to be taken into account in passing on the practical merit of any coating material:

(1) Its availability, which involves the sources of raw material, the equipment and processes used in its manufacture, price, etc.

(2) Its general characteristics in liquid form, such as inflammability, toxicity, odor, keeping qualities, possibilities in color range, gloss range, etc.

(3) Its application, including the preparation of undersurfaces, speed of drying, cost of application, etc.

(4) Its performance after application.

All the ingredients of the modern lacquer are obtainable in practically unlimited quantities at fairly stable prices. There is reason to believe that the supply of these materials will constantly increase and that their cost will diminish. They are obtained either synthetically or from raw materials such as cotton, corn, coal, etc., of which there will always be an adequate supply. Some fossil gums are now used in many lacquers, but this is not obligatory, and there is certainly nothing to indicate that the use of lacquer will ever be limited through the exhaustion of natural deposits of these resins.

The manufacture of lacquer, while requiring technical knowledge and experience of a high order, does not call for as large an initial investment or as much floor space per unit of output as does the manufacture of oleo-resinous coatings.

The cost per gallon to the consumer of industrial lacquers now on the market is greater than the gallon cost of corresponding oleo-resinous materials. The real finishing cost, which takes account of lessened floor space, greater output per man hour, much reduced inventory tie-up, increased durability, and lessened sales resistance, is much less.

The general characteristics of lacquer during manufacture and before application are not unlike those of other materials. Its friendly enemies have dwelt on its inflammability. The fact that nitrated cotton is one of its ingredients seemed to present a delightfully easy point for attack. But there are different kinds of nitrated cotton (depending on the degree of nitration), and pyroxylin, the particular kind used in lacquers, although inflammable, is not explosive. When mixed with solvents and with the usual gums and pigments it is perhaps as dangerous as a can of cut shellac.

The most dangerous common lacquer ingredient both from the point of view of inflammability and of toxicity, is undoubtedly benzene, but as this has been used for many years in non-lacquer coatings I will not dwell on its properties. Aside from benzene and similar coal tar products, all of the common lacquer ingredients are practically non-toxic.

There has been much talk about the odor of lacquer. In this connection let me emphasize the fact that odor and toxicity are two very different things. Many highly poisonous gases are completely odorless; and certainly the epicure who prefers his Camembert soft would repudiate the suggestion that he is a poison addict. As to odor we must, in dealing with lacquers, make a clear distinction between odor of the vapors during evaporation of the solvents and residual odor which may remain in the film after it is in use. In industrial finishing, odor of evaporation is not a factor because fortunately the sense of smell is highly accommodating and our noses soon cease to register a smell which on first exposure may have seemed even nauseating or irritating. After working for a few days in the usual concentration of these vapors men cease to notice the smell at all. It is, therefore, rather to guard against toxic effects than to diminish odor that manufacturers equip their finishing rooms with ventilative fans and spraying hoods.

In the case of brush lacquers odor of evaporation is less, other things being equal, than with spray lacquers because the need for longer flow and slower drying calls for the use of solvents whose rate of evaporation is relatively slow. Furthermore, it is quite possible to obtain a solvent mixture of proper volatility which has little, if any odor, even during evaporation. Residual odor in a lacquer film is entirely due to impurities in one or more of its ingredients. All the usual lacquer ingredients are available today in such purity as will obviate any risk of residual odor.

The keeping qualities of lacquer are about the same as with other materials. Exposure to heat tends to reduce viscosity, and, of course, im-

pure ingredients may result in the formation of an excess acidity, but these difficulties are unimportant or can be avoided. Lacquer may be clear, stained, or pigmented. The possibilities in color are at least as wide as in the field of oleo-resinous materials.

There is, perhaps, a popular idea that a lacquer finish must be less glossy than an oleo-resinous film. It is true that a polished film of pigmented lacquer has less depth than an enamel film on which one or more coats of transparent varnish have been applied, but the difference cannot be detected by casual observation. Depth of finish is a function of transparency and thickness. On automobiles, in order to get full lacquer durability, and because a pigmented lacquer film is much more resistant to sunlight than a clear film, we usually dispense with the clear final coats.

In its application, owing to rapid drying, lacquer should be put on evenly and rapidly. Fortunately, mechanical appliances for suitable application of this material have recently been brought to a high state of perfection. The modern air gun not only enables the industrial finisher to obtain perfect application, but also greatly increases the area which his men can cover per unit of time, as compared to what they might have covered with a brush. Lacquers have recently appeared on the market designed for brush application. This will make lacquer available to small users, housewives, etc., who could not have considered its application by mechanical means. The apparent obstacles in the way of this development have been largely overcome, and it is now possible to obtain brushing lacquers which not only have enough flow to leave a smooth surface, but which also have that property which permits successive coats to be applied without damage to the preceding coat of similar material. Although there will probably, in the aggregate, be a wide demand for brush lacquer, it is my opinion that mechanical application has advantages in the industrial field which will restrict the use of brush lacquer to non-industrial application.

A lacquer film has much higher tensile strength per unit area of cross section than other similar materials. It is not uncommon to find lacquer films with a tensile strength of about 10,000 pounds per square inch. This characteristic, while of great advantage in many ways, makes it necessary to strengthen other links in the chain to an almost corresponding degree. Adhesion, for instance, is very important. However strong a lacquer film may be, it becomes inferior to a much weaker film if it fails to adhere to its underlying foundation. Expansion and contraction caused by changes in humidity and temperature must be met in a lacquer film by sufficient plasticity or extensibility to permit it to remain in place; but even aside from expansion and contraction, it is necessary that a lacquer film have such adherence that it will not continue to peel or chip off if some accidental mechanical injury breaks the film at any point.

In order to get sufficient extensibility, we may sacrifice some of our tensile strength and hardness, but just as steel is stronger and at the same time more elastic than lead, so a lacquer film is stronger and more elastic than an oleo-resinous film, although its plasticity is far less.

Poor adhesion is often the result of bad surface preparation. As the balance of a lacquer formula is upset by the presence of even small amounts of certain incompatible substances, it is important that the surface to be covered be cleaner than is necessary when oleo-resinous materials are applied. The manufacturer who takes up lacquer for the first time occasionally is slow in realizing the importance of surface preparation; but this trouble will gradually disappear.

A coat of lacquer dries in a few minutes. This is one of its most useful characteristics, but here again the user may have to readjust his old ideas. The common type of blush (the appearance of a white cloud in the drying film) is an indirect result of this speed in drying. Lacquers can be made which will dry without blushing, even in air which is almost saturated but such lacquers would be unnecessarily expensive. With commercial lacquers, it is, therefore, customary to avoid extreme humidity and to maintain a room temperature of between 65° and 90° Fahrenheit.

Recently developed materials and methods for polishing give us as high a degree of surface luster with lacquer films as with other equally pigmented materials.

The greater strength, toughness, and resistance to wear of a lacquer film enable us to use it in thinner layers than would be at all practicable with oleo-resinous materials. This diminished thickness naturally means less filling power. It is, therefore, usual to put lacquer on smooth undersurfaces. Where much building up is necessary it is customary to use old style materials for the undercoats as their greater thickness per coat and lesser resistance to sanding permits economies in sanding time and material. But it is likely that even these old style materials will soon be replaced by newly developed pyroxylin primers and undercoats which dry rapidly at room temperature.

The actual cost of application varies greatly with the nature of the work. If dipping lacquer is used the cost should be the same as with other materials. Elimination of drying ovens is sometimes an important cost factor.

The fact that lacquer dries entirely through evaporation rather than through oxidation is an advantage not only in its practical use, but it also enables us experimentally to determine in a much quicker time just what its continued performance is likely to be.

The best indication of how lacquer behaves after application is the remarkable way in which its uses have been recently extended. Lacquer is now used on a great variety of surfaces. Many locomotives, passenger

cars, tank cars, trolley cars, buses, trucks, and nearly all American makes of automobiles are being lacquered today. Steel frame-work and even exterior sandstone and skylights have been lacquered, at least experimentally. In the Book-Cadillac Hotel at Detroit, above the mezzanine floor, all the wood and metal trim is finished in lacquer. A textile mill in New England has been refinished in white lacquer enamel. A considerable percentage, possibly forty per cent of the furniture now made in this country is being finished in lacquer, both clear and pigmented. Many ice-boxes, filing cabinets, and a great variety of miscellaneous objects and novelties are now being lacquered.

Lacquer gives a beautiful and a durable finish and its use saves time. We have, in these characteristics, the explanation of its recent growth and future promise.

Soap Found Good Germ Killer. "Hot soap suds and water," the good, old-fashioned remedy for all cleansing purposes, has real germicidal properties, according to experiments carried on at the Army and Navy General Hospital, Hot Springs, Ark., by Dr. J. E. Walker.

In a forthcoming issue of the *Journal of Infectious Diseases*, Dr. Walker says that any ordinary soap used with a reasonable degree of care will kill several kinds of bacteria, notably those that cause pneumonia, gonorrhea, diphtheria and several of the pus-forming organisms. The dysentery and typhoid bacilli die harder. Strong soaps made of what is known as saturated fatty acids are necessary to annihilate these tough ones. A salt water soap, prepared exclusively from cocoanut oil, is the most readily available efficient soap to rid the hands of possible typhoid bacilli. Unfortunately an all cocoanut oil soap is too irritating to the skin for ordinary use.—*Science Service*

Cadmium Plating Protects Steel. Cadmium plating is as effective in preserving iron and steel from corrosion as zinc, metallurgists at the U. S. Bureau of Standards find.

Zinc plating or "electrogalvanizing" is especially valuable in commercial processes because it continues to act as a protection to the underlying iron or steel even when partially worn away. This is the result of an electrochemical reaction between the base metal and the coating. The two in contact with a liquid such as a water solution of any chemical salt act like a wet battery. Automobile parts subject to corrosion, such as rims, nuts, and bolts, are common examples of electrogalvanized iron.

Cadmium has been suggested for use in this way but it was not previously known just how it would react. The experiments carried out in the metallurgical division by H. S. Rawdon have demonstrated that it behaves in much the same way as zinc, with some advantages and some drawbacks.

It is less readily attacked by air and moisture and in consequence stays bright longer than zinc. It could suitably replace nickel plating in many places and it would give much more lasting protection to the iron or steel base. Likewise a coating of cadmium will last longer than a coating of zinc of the same thickness. It has, however, the serious disadvantage of being expensive to prepare. It is possible that it may be made more cheaply if the demand is ever sufficient to stimulate large quantity production.—*Science Service*

HOW MANY COLLOIDS HAVE YOU USED TODAY?

V. N. MORRIS, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

Increasing Interest in Colloids

In a recent issue of THIS JOURNAL,[1] the editor took occasion to call attention to the steadily increasing interest which is being manifested in the study of colloids. A good indication of this interest is given by an analysis of the registration at the Third National Colloid Symposium held at the University of Minnesota during the past summer. That the symposium attracted widespread attention, considered from the geographical standpoint, is evidenced by the fact that visitors were registered from Canada, South Africa, and some of the European countries, as well as from nearly two-thirds of the states of the union. Further proof that interest in colloids is not a highly specialized one is offered by the fact that the symposium not only drew chemists, chemical engineers, and teachers of chemistry in large numbers, but also representatives of such widely diversified sciences as physics, horticulture, pharmacology, bacteriology, metallurgy, biology, pharmacy, and botany.

At the conclusion of the editorial mentioned above the hope was expressed that the teachers of chemistry would not be the last to recognize the "handwriting on the wall," and would allot to the consideration of colloids an appropriate amount of time. While it is realized that courses discussing in some detail at least the theoretical aspects of colloids are now given at a number of institutions, there are, however, undoubtedly many other courses in elementary physical, general, or other branches of chemistry which have become so well standardized that opposition is encountered in any attempt to take time away from any of the old orthodox subjects and give it to colloids. It seems to the author, however, that, if judiciously expended, any time devoted to a consideration of colloids in such courses will be anything but wasted.

Suggestions for the Presentation of the Subject

In taking up the subject of colloids, some time must necessarily be applied to a brief discussion of the theoretical considerations. The student should be given a brief introduction to the nature, classes, methods of preparation, and some of the peculiar properties, such as adsorption, flocculation, protective action, hydration, etc. Lacking time to go farther into the subject, the instructor can furnish inspiration and arouse considerable interest by a final lecture depicting the contacts which the student has with colloids during the course of his ordinary daily life. There follows a description of a number of such contacts, presented in the manner which the author has found will stimulate interest among both students and faculty members.

[1] THIS JOURNAL, 2, 518 (1925).

Colloids in Washing

The student begins his day, after delaying it as long as possible in order to recuperate from the burning of midnight oil (or other midnight activities) by dragging himself out of bed, gathering up his towel and wash cloth, and starting for the bathroom. There he picks up a bar of soap, without being aware that he has a handful of colloids of the emulsoid type, as demonstrated by their tendency to give viscous solutions, their power of gelation, etc. Using these colloids, he proceeds to carry out a colloidal process, that of washing, during which adsorption and other colloidal phenomena come into play.

If the hour of his first class is not too imminent, he may make a thorough job of it by jumping into the bathtub, little realizing what knowledge of colloid chemistry may have been applied during the manufacture of that tub. In the older method of making tubs, it was necessary to mould them, and as a consequence cracks and deformations were common. A study of the clay from which the tubs are made revealed it to be a colloid carrying a negative charge, and consequently capable of being peptized by alkalies. It was later found that alkalies at higher concentrations tended also to so peptize the tannins and other protective colloids present that eventually a molecular condition is reached and the protective action lost. Silicate of soda was also discovered to have a deflocculating effect, so that the former stiff, plastic mass could be made so fluid that a "pouring" process could replace the earlier one of moulding. Although more fluid, this material really has less water. By the application of the principles of colloid chemistry it was thus possible to obtain a faster drying and better product.

Colloids in Clothing

Having completed his ablutions, our hero dashes back to his room only to encounter another group of colloids as he picks up his clothes. The wool in his trousers and the cotton of his shirt are both largely made up of colloidal particles, as are also his socks, whether real silk or only of the artificial variety. The cellulose of the cotton fiber, for example, can readily be shown to be colloidal in nature, on account of its electrical charge, its tendency to become hydrated, and its ability to adsorb acids and bases from solution. Depending upon the taste of the owner, his clothing may be of various colors, but whether in the case of the black of his socks or the brown of his coat, the dyestuff used was probably colloidal, and adsorption may have played a role in its application.

Not content with being wrapped in colloids, he puts some more on under foot, as he laces up his No. 11's. The skin, from which his shoes originally came, was so colloidal in nature that it might have been used as a source of that very popular colloid, gelatin. Moreover, the tannins and many

of the other substances used in making leather from that skin are also colloids. Incidentally, if his shoes are well shined, as we trust is the case, he has them covered with a thin layer of a non-aqueous colloidal solution.

Before leaving the room, he combs his hair with a celluloid comb, in the manufacture of which camphor and moist pyroxylin are ground together, dehydrated by pressure, sprayed with alcohol, and given such subsequent treatment that the final product is a colloidal gel. While he may allow his thoughts to dwell with some uneasiness on any gray hairs he combs out, our student will, of course, have no thought of the possibility that the color of those very hairs may be attributed to the presence of air bubbles of colloidal size in the hairs.

Colloids at the Table

With his personal appearance entirely to his satisfaction, he is now ready to present himself for breakfast. Were he one of those hearty eaters, who crowd a lot of heavy proteins down their throats at the first meal of the day, his stomach would soon be filled with colloids. Just because he prefers a cereal instead is no reason for thinking that he can escape them. Whether he chooses Shredded Wheat, Quaker Oats, or even Grape-Nuts, "there's a reason" for classing his breakfast among the colloids. Over his cereal he pours milk—or cream perhaps, if he happens to be in a state of affluence—but in either case he pours colloids.

As a beverage he may have milk, tea, or coffee, all of which swarm with colloids. (For those who are skeptical a few experiments in dialysis or electrophoresis of coffee are suggested.) Even if he is a member of that large class of citizens who consider the Volstead Act as no act at all, and has beer as a beverage, he is still not avoiding colloids. Beer would not froth so well, nor be so turbid when nice and cold, were it not for its colloidal content. Who can say but that the reason the manufacturers of near-beer have been called such poor judges of distance is because they have not made proper use of the chemistry of colloids?

If his choice has fallen on coffee or tea, he will probably also want toast, and where else could be found a better illustration of some of the colloidal phenomena? The making of bread is, in the first place, a process of the formation of a gluten emulsion which contains suspensoid starch. Upon becoming stale the colloidal character is less pronounced, as the degree of dispersion has probably decreased, and a loss of water has occurred. In toasting, this process of dehydration has been unduly hastened, so that the resulting product not only tastes different, but is structurally different from stale bread.

Colloids in Books, etc.

Having completed breakfast, he hurries back to his room to get his books together, and once again comes in contact with these omnipresent

colloids, which are to be found in the paper, the ink, the cloth, and the glue. One of the functions of the beater in paper making is to hydrate the cellulose, the hydration resulting not only in a swelling but probably an increase in the degree of subdivision as well. The paper was probably sized by allowing aluminum sulfate and silicate of soda to react, the resulting gelatinous precipitate being adsorbed by the paper to give the latter a better finish. As for the glue, it need merely be mentioned that the properties of this substance were so well-known by the father of colloid chemistry, Graham, that he named this new branch of the science after it.

Even the pictures in the books have had intimate contact with colloids from the very moment of their origin. The medium of the so-called photographic emulsions is usually gelatin or collodion, while suspended therein are the silver halide sols. Gelatin, if used, functions not only as a binder and dispersion medium, but also retards reduction of the suspended silver salt in the absence of light. It now appears probable that both the latent and visible images represent dispersions of a small amount of colloidal silver in a relatively large amount of silver halide. The work of several investigators, who have prepared photohalides synthetically, starting with sols of silver and of silver halides, has helped to discredit the older theory of the existence of silver subhalides. In the process of development adsorption comes into play in the first stage, while other colloidal phenomena follow in the subsequent phases. Moreover, in the final process of fixing, *i. e.*, removal of the residual halide by "hypo," colloidal considerations are still involved, since the hydration of the gelatin must be so maintained as to allow proper diffusion of the "hypo."

But to get some more action out of our hero, we will say that he takes out a cigarette and lights it, failing, of course, to see any connection between the luminosity of the flame from his match and any carbon particles of colloidal size that may be present. He then picks up his books and his fountain pen, which is quite probably filled with colloidal ink, and starts for his first class. Incidentally, we cannot let that fountain pen be mentioned without calling attention to the fact that it is made of hard rubber, and as such merits discussion with the colloids. Rubber, among other things, illustrates very nicely that property of some colloids which is manifested by their ability to take up liquids and swell. Although raw rubber best illustrates this property, even a vulcanized rubber band, when dropped into benzene or other organic liquids, will swell to several times its original size.

Colloids in the Open

It might seem reasonable to expect at least a temporary freedom from colloids during the short trip to the campus. The insidious thing about these little fellows, however, is that, like halitosis, "you rarely know

when you have them and even your closest friends won't tell you." The air which surrounds our student as he walks along is filled with colloidal moisture and dust particles, whose deflecting power on that mixture of variously colored rays whose composite effect is that of white light, accounts for both the blue of the ordinary sky and the red of the sunset. Incidentally, a close observation of the cloud of tobacco smoke which he is puffing out will show it to be blue by reflected light and red by transmitted, just as is the atmosphere.

The only hope of escape now is under foot, but that hope is soon lost, as we find him traversing a concrete walk. In the process of the setting of that walk, a calcium silicate gel has formed in the interstices between particles and as the mixture hardens, water leaves this gel and enters the cement particles.

Even if he happens to be passing a group of co-eds, in which case, of course, he would be crowded off the walk entirely, he will be right on top of the biggest mass of colloids of all. There is generally an intimate relation between a soil's content in colloids and its fertility. Farther down below the surface are the stones and particles of very coarse dispersion, whose disintegration helps to produce soils. Nature has provided some very beautiful mineral formations, some of which, such as the banded agates, may be closely imitated in the laboratory.

It would obviously be too long a process to follow our friend through his entire day, so we will leave him in peace as he enters his first class, sits down, opens up his note-book, and takes on a bored expression, which is decidedly indicative of his blissful ignorance that he, personally, has ever had anything to do with those tiresome substances, colloids, which the professor is again starting to discuss.

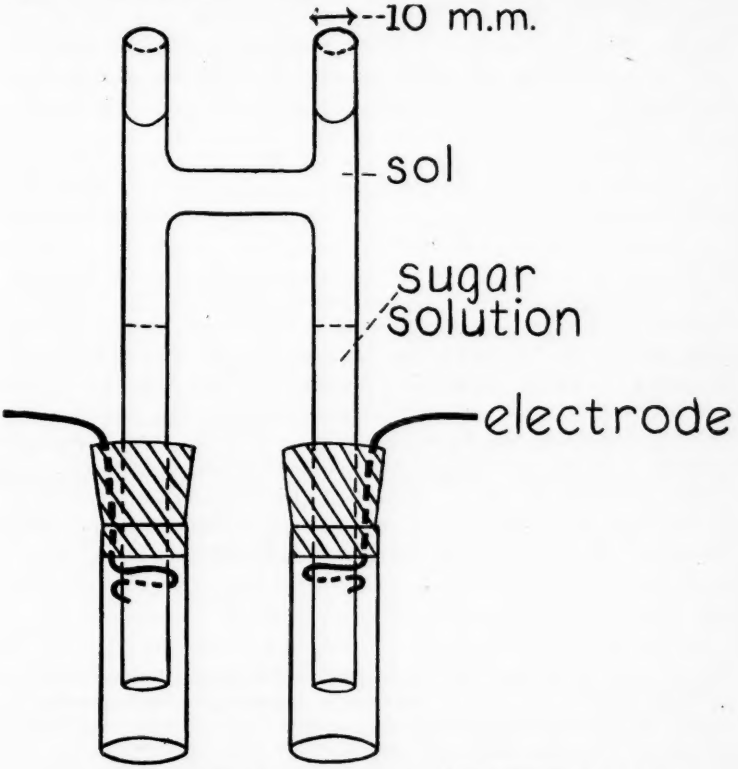
Diabetes Cured by Protein Injection. Diabetes can be cured by a new treatment, according to an Austrian physician, Dr. Gustav Singer, who recently reported the results of his researches before the Vienna Association of Physicians, after several years of investigation on animals followed by a number of clinical cases.

Dr. Singer was impelled to his investigations by what he regarded as serious drawbacks in the use of insulin, notably its somewhat unpleasant after-effects and the fact that it benefitted the patients only temporarily, the diabetes returning as soon as the treatment was discontinued. His new method consists simply in the injection of certain proteins into either the body tissues or the blood stream. This, he claims, immediately allays the diabetic symptoms and quickly makes it possible for his patients to resume an ordinary diet. The effect is much more lasting than that of insulin, having persisted for six months or more in more than twenty cases. Dr. Singer states that in the clinical cases thus far treated 55 per cent of the patients have shown substantial improvement. An especial advantage which Dr. Singer claims for his treatment is that diabetic patients, the majority of whom are of working age, are able to go about their daily occupations without inconvenience while they are undergoing treatment.—*Science Service*

A SIMPLE APPARATUS FOR DEMONSTRATION OF CATAPHORESIS

R. E. GREENFIELD AND A. L. ELDER, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

In presentation of the elementary facts of colloid chemistry, a demonstration of the charge on the colloidal particles by means of a cataphoresis experiment is highly desirable. Unfortunately, most devices described



A simple apparatus for demonstration of cataphoresis.

for such experiments are either unreliable, complicated to build, often involving glass blowing which cannot readily be done in most laboratories, or have the boundary of the sol immediately above or below stopcocks where it cannot readily be seen in a class demonstration.

A simple device has been developed which, on most of the ordinary sols used, gives a very quick and easy qualitative demonstration of cataphoresis, which is visible at a considerable distance from the apparatus.

It consists of an **H**-shaped piece of glass tubing, two legs of the **H** being longer than the other two. Glass test tubes or bottles are stoppered onto each of the longer limbs of the **H** and a suitable wire electrode passed through each stopper. The electrode is wrapped around the portion of the glass tubing projecting through the stopper.

Each bottle and the lower halves of the longer limbs of the **H** are now filled with a $N/1000$ KCl solution to which has been added enough sugar to make the solution of an appreciably greater density than the sol to be studied. With gold or other ordinary suspensoid sols 5–10% sugar was found to be suitable. The sol to be studied is carefully pipetted onto the sugar-KCl solution to form a supernatant layer in the upper portion of the **H**, filling it to a point above the crossbar.

If a suitable e. m. f. is impressed on the two electrodes a movement of the two boundaries of the sol is easily noted. With 110 volts d. c. a movement of a quarter of an inch in fifteen minutes was obtained with a negative gold sol and a positive ferric oxide sol. Upon reversal of the polarity, a reverse movement of equal magnitude was demonstrable.

Several such devices can be connected in parallel for the comparison of various sols. Since the **H**-crossbar need not be fused together as shown in the illustration, but may be joined by means of a rubber tubing, such an apparatus can be assembled in a laboratory from ordinary **T**-tubes.

Simple copper electrodes give very good qualitative results. It is true that a small amount of gas is liberated at such electrodes, which tends to introduce an error in the movement of the boundaries of the sols. The magnitude of this error is not great. Silver-silver chloride electrodes can be prepared which do not liberate gas. For ordinary lecture demonstration the simple copper electrodes are to be preferred.

Thousands of Babies Treated with Calmette Tuberculosis Vaccine. Babies of four nationalities have been treated with the most recently perfected tuberculosis vaccine of Prof. Albert Calmette of the Pasteur Institute. In an account to the Academy of Medicine of his latest results in the protection of newly born children against tuberculosis, he states that 5000 babies have been subjected to this treatment in France, 117 in Belgium, 3352 in Indo-China, and 218 in Senegal, West Africa.

All of these children were born in tuberculosis-infected households and the vaccine was administered either through the mouth or by inoculation before they were ten days old. Up to date less than 2 per cent of them, Prof. Calmette says, have succumbed to the disease—a striking reduction of the average mortality of 25 per cent for European children in tuberculosis homes. In Paris the average is even higher, reaching 32.6 per cent.

The vaccine apparently produces no harmful results while the immunity it confers lasts, according to Prof. Calmette, from 15 to 18 months. He recommends for best results revaccination at the end of the first and third years.—*Science Service*

MENTAL PROCESSES REQUIRED IN EXAMINATIONS IN CHEMISTRY

STEPHEN G. RICH, VERONA, N. J.

In addition to knowledge of the proportions in any examinations given to the various portions or subdivisions of chemistry, a knowledge of the relative frequency with which the various mental processes are required is useful information to the teacher whose pupils have to meet such examinations. So dominant are the examinations of the College Entrance Examination Board throughout the eastern states as a whole, and those of the Regents in New York state, that instruction has substantially the same mental character as these examinations. "Schools for concentration" and other examination-passing schools have for years past operated with success on the assumption that memory work alone could insure a pass. In the belief that this assumption should be either verified or disproved, the present study was undertaken. It is an extension of a portion of a study suggested by Dr. Daniel Starch, and made under his direction.[1]

The present expanded study deals with a typical cross-section of the examination situation composed of ten Regents' examinations and fifteen Board examinations in chemistry covering the years 1913 to 1922, inclusive. Since 1922 neither series of examinations has varied appreciably in mental content from those of the years preceding; hence the data here given will hold substantially true up to the time of writing.

The data were secured as follows. A preliminary study of a few examinations was made, in order to determine the types of mental processes required in answering the questions; from this a classification was made and revised by study of more samples of the examinations. After a satisfactory classification was arrived at, the examinations were gone through *seriatim*, tabulating under each heading each response belonging to it. Each part of a question which could be counted separately toward credit in passing the examination was counted as a separate item, unit, or response. Relative values given in marking, as on the Regents' examinations, were disregarded, especially as this would have resulted in an undue weighting of the proportion of memory work. Such units as required two or more kinds of mental activity were entered under each; in no case did any unit require to be entered more than three times.

The mental processes involved in each unit or response were determined from the following sources: (1) The writer's introspective data; (2) the correct answers or solutions as given in the well-known "cram-books" published by two firms in New York state and covering Board questions as well as Regents'; (3) information from teachers of the sub-

[1] A similarly expanded study, based upon the remainder of the study made for Dr. Starch, and dealing with biology, has already been published: Rich, S. G., "An Analysis of Current Examinations in High-School Biology," *Sch. Sci. Math.*, **23**, 254–7 (1923).

ject, of whom inquiry was made; (4) information given by students in the writer's classes. It appears probable that the joint results from these sources are reasonably accurate and reliable. A consistent effort was made throughout the gathering of information to weight the scoring against memory work; that is, every effort was made to count items under non-memory headings rather than memory, whenever possible.

From the writer's experience and the opinions of other chemistry teachers, it appeared desirable to subdivide the general group of memory responses into several groups. This was done in accordance with the basal idea that the various types of memory are independent of each other and that pupils frequently are excellent at one type of memory work and poor at others. From the writer's experience and the opinions of both chemistry teachers and educational psychologists, six groups of memory responses were finally differentiated; three of these are verbal-memory responses.

The "Old Plan" examinations of the Board, given in June of each year from 1913 to 1921, inclusive, and also in September of 1920; the "comprehensive" examinations of that same body given in June of each year, 1916 to 1920, inclusive; and the Regents' examinations, beginning with that of January, 1916, alternating June and January from 1917 to 1920, and including both January and June examinations of 1921 and 1922, formed the material studied. Table I gives the results as found for each of these groups and for the whole group of examinations.

In interpreting these figures, the chief difficulty lies in the assignment to specific mental functions of the equations and computations. These two groups would, off-hand, be considered as questions involving thinking. But knowledge of the mental processes involved in arithmetical work and algebra shows that, at least in large part, computations and symbol-work are neither more nor less than a series of mechanized habits of response. A reasonable stand is to apportion the equations and the computations equally between the thinking and the habit categories. This practice has been followed in this study.

Owing to the fact that the percentages are computed to three figures only, they add up to slightly less than 100%. This difference was arbitrarily assigned to the category of "thinking," and, in order to avoid any possible injustice in considering responses on laboratory work as entirely memory, was taken as representing the thinking involved with such responses. The reader will recall, however, that the practice of entering each unit or response under each group in which it occurs, so that one response may be entered up to three times, has already provided for the thinking element in responses on laboratory work. The weighting is, however, in accord with the general policy of weighting against memory, pursued throughout the tabulation.

TABLE I

DISTRIBUTION OF MENTAL PROCESSES REQUIRED IN THE VARIOUS EXAMINATIONS: TOTALS

Group	Nature of mental process	Board (Old Plan) Number of responses	Board (Old Plan) Per cent	Board (Comprehensive) Number of responses	Board (Comprehensive) Per cent	Regents Number of responses	Regents Per cent	Sum of All Examinations Number of responses	Sum of All Examinations Per cent
A	Verbal memory for names and definitions	66	11.3	70	21.5	109	20.7	245	17.1
B	Verbal memory for symbols and formulas	80	13.6	30	9.2	53	10.0	163	11.4
C	Verbal memory for laws and theories	22	3.7	19	5.8	18	3.2	59	4.1
D	Memory for laboratory work done	94	16.0	34	10.7	64	12.2	192	13.4
E	Memory for commercial uses, properties, etc.	117	20.0	60	18.4	107	20.6	284	19.7
F	Memory for other facts	50	8.5	28	8.6	55	10.5	133	9.7
G	Equations to be written or completed	93	15.9	49	15.0	74	14.0	216	15.1
H	Thinking other than equations or computations	17	2.8	14	4.3	12	2.2	43	3.0
I	Computations	41	7.1	22	6.8	33	6.2	96	6.7
	Totals	530		326		525		1431	

TABLE II*

DISTRIBUTION OF MENTAL PROCESSES FOR A FEW TYPICAL EXAMINATIONS. ALL FIGURES ARE NUMBERS OF RESPONSES

Group	Regents Jan., 1918	Regents June, 1922	Board (Comprehensive) June, 1920	Board (Comprehensive) June, 1918	Board (Old Plan) Sept., 1920
A	14	10	12	4	15
B	8	4	5	10	3
C	0	5	6	2	2
D	6	8	6	1	8
E	13	12	16	15	7
F	10	5	6	5	6
G	7	4	5	13	10
H	0	0	2	1	3
I	2	3	4	4	6
Totals	60	51	61	56	55

* The complete set of distributions for each of the 25 examinations studied will be found in the author's thesis in the library of New York University; copies of all or any portion of these results will be supplied on request by the author.

With these points of view in mind, the next two tables are presented, interpreting the results of the tabulations:

TABLE III

SUMMATION OF RESPONSES UNDER MAJOR HEADS OF MENTAL ACTION

	Sum of All Examinations	
	Number of responses	Per cent
Memory questions (Groups A to G, inclusive)	1292	90.0
Verbal-memory questions (Groups, A, B, and C)	467	32.7
Possible habit-questions (Groups G and I)	312	21.8
Possible thinking questions (Groups G, H, and I)	355	23.8

TABLE IV

ADJUSTED SUMMATION OF RESPONSES UNDER MAJOR HEADS OF MENTAL ACTION, DISTRIBUTING EQUATIONS AND COMPUTATIONS BETWEEN HABIT AND THINKING

	Sum of All Examinations	
	Number of responses	Per cent
Memory	1180	82.5
Thinking	151	10.5
Habit	100	7.0
	1431	100.0

The figures in Table I will show how closely the computations made for the whole set of examinations apply to any one of the three component sets. It has, therefore, been deemed unnecessary to submit figures for the major heads of mental processes for any component set, in both the adjusted and the raw totals. In no case is the difference from the percentage results (adjusted), as given for the sum of all examinations, greater than 2 per cent for any one of the three sets in any one of the three major heads. Furthermore, study of the original tabulations of the separate examinations shows that, although there is a wide variation from year to year within each set, the total proportion of memory work, habit work, and thinking remains substantially constant. Such variations as occur are mainly within the various categories of memory. Furthermore, any two successive examinations out of any one of the three series give, when combined, a distribution of mental processes within 5 per cent on each major head of the figures for the sum of all examinations.

The conclusions are:

(1) Over the period studied, the proportions of the various mental processes required in answering the various examinations are substantially constant within each set.

(2) The proportionate distribution of mental processes is substantially the same for College Board Old Plan examinations, for College Board Comprehensive Examinations, and for New York State Regents' Examinations in chemistry.

(3) Despite all attempts to weight the study against emphasis upon memory, it was found that all these examinations consistently require 82.5 per cent of all responses to be memory responses of various sorts;

but there is great fluctuation from year to year in the kinds of memory required.

(4) Verbal memory rather than any other kinds, is called for, in its various subdivisions, in 32.7 per cent of all responses.

(5) Habits, mainly arithmetical and algebraic, are required for 7.0 per cent of all the reponses.

(6) Thinking is called for in 10.5 per cent of the responses.

A supplementary study to indicate the extent to which the responses are dependent upon language training and language ability rather than upon chemical knowledge or chemical thinking, for their acceptability as correct, is desirable. Meanwhile, the present study will suffice to indicate the extent to which high-school chemistry has been and still is a subject requiring principally memory work on the part of students. For it will be not unknown to teachers that *even in classes not preparing for them*, the Regents' and Board examinations set in large measure the norms of emphasis and content of instruction.

Whether this large proportion of memory work is well or ill adapted to the purposes of chemical instruction in high schools cannot, of course, be discussed here. The recognition of the fact that chemical instruction is at present primarily and predominantly memory work will, however, be the starting point for its improvement in any respect.

New Insecticide Made from Air. Consternation among the bug pests of southern California is expected to follow the introduction of calcium cyanide, a new death-dealer which appears to be the most powerful agricultural poison yet known. Information just released here by Dr. Robert W. Poindexter, cyanide chemist, indicates that a long period of industrial research has now put calcium cyanide into the commercial arena. The product as now made in southern California is prepared largely from the nitrogen of the air and from natural gas.

Recent field tests show that calcium cyanide is much more potent than pure hydrocyanic acid, or prussic acid, heretofore considered the ultimate 100 per cent of toxic power. This unexpected result so far is not explained. After one test of calcium cyanide this winter in an orange grove, where a very resistant strain of scale insects was infesting the foliage, only two bugs were found alive among over 3000 insects actually counted. This record is especially encouraging to growers who have found the scale pests gradually developing immunity to regular doses of hydrocyanic acid. As one orchardist suggests—"the ancestors of the scale have been killed so often that their progeny don't mind it any more."

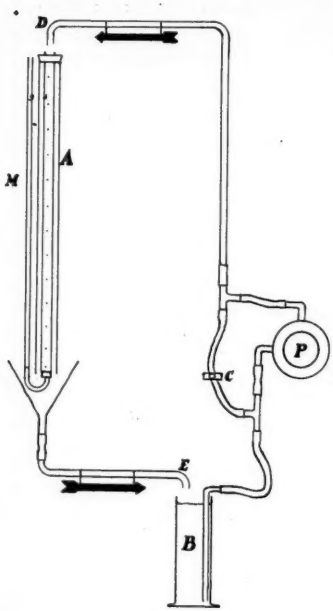
Calcium cyanide, while theoretically appearing to be a simple preparation to the ordinary chemist, is impossible to make in any ordinary way. By combining calcium carbide with hydrocyanic acid, however, a light brown powder is secured, and this substance has the remarkable power of pouring out a veritable wave of poison gas when it is merely exposed to common air. Fumigators simply blow the poison in a dust cloud under the regular orchard tent; and whatever animal was living under the tent dies, regardless of whether it be a scale insect, a luckless owl or an itinerant rooster.—*Science Service*

DEMONSTRATING CHEMICAL EQUILIBRIUM

NORRIS W. RAKESTRAW, OBERLIN COLLEGE, OBERLIN, OHIO

The conception of chemical equilibrium as a condition of balanced velocities rather than one of rest is difficult for the mind of the beginner to grasp. To make this point impressive the writer has made use of a hydraulic analogy which is easy to demonstrate, simple to understand, and sufficiently like the chemical condition to serve as a reasonable example.

A diagram of the apparatus is here shown. The two sides of the "reaction" are represented by chambers *A* and *B*, into and out of which a liquid can be pumped to represent the two opposing reaction velocities. *A* is made of a piece of $^3/_4$-inch iron pipe about two feet long, with small holes drilled into it about two inches apart. A manometer, *M*, is fitted to the bottom of the pipe to serve as an indicator for the water level within and the pipe then enclosed in a large glass tube, open at the bottom, to collect the water from the small apertures. This is delivered into a large funnel supported below, whence it drains into the cylinder, *B*. From this it is taken up by a power-driven pump, *P*, and delivered again into the top of *A*. An auxiliary water-circulation pump, such as is used on Fords, serves very well, and, to regulate the flow delivered at *D*, a "by-pass" with a clamp, *C*, is most conveniently used. By closing or opening *C* the flow at *D* is increased or decreased, respectively, while the pump is operating at constant speed.



The velocity with which water is delivered at *D* determines the height in the manometer, *M*. But, on the other hand, the more water in *A* the more rapidly will it run out through the small holes and the more rapidly will it be delivered through *E* into the "reaction chamber," *B*. Constant levels in *M* and *B* will result, corresponding to constant proportions between reacting constituents in a reversible chemical system. With the pump working at maximum capacity the level in *M* should stand near the top, and in *B* near the bottom. On opening *C* the velocity at *D* falls off, the level in *M* sinks and in *B* rises, reaching finally a new equilibrium when the flows at *D* and *E* are equal. Every teacher will,

of course, devise his own "patter" to accompany the demonstration.

The water is, of course, colored by a dye or by permanganate to render it visible at a distance and a white background is placed behind *M* and *B*. It also makes the analogy more impressive to hang black or red arrows on the two tubes carrying the opposing "reactions."

Another point which can be demonstrated with the same apparatus is the nature of the "reaction velocity curve." When *A* is filled to the maximum height the flow at *D* is suddenly shut off completely and the level in *M* observed. The latter will, of course, sink rapidly at first and more slowly as it gets lower, corresponding closely to the course of a first order chemical reaction.

A little experimentation will usually be necessary in choosing the size of tubing, etc., especially the length and size of the pipe in *A* and the diameter and number of the holes in it, according to the capacity of the pump used. The tube, *E*, must also be large enough to deliver into *B* as rapidly as the full capacity of the pump requires.

Smallest Bacteria Revealed through Coating with Gold. A new and original method, by which ultra-microscopic particles a thousand times smaller than those observed with the aid of ultra-violet light may be rendered visible, is described by Prof. H. Bechold of the Institut für Kolloidforschung at Frankfort-on-Main. Prof. Bechold is already very well-known in scientific circles as a colloid chemist. The method is based on the discovery of Sir W. B. Hardy, F. R. S. that negatively charged colloidal particles combine firmly with certain metals.

Prof. Bechold began by immersing paratyphoid and other bacilli visible under the ordinary microscope in a solution of gold chloride, and subsequently reducing them to ash on a microscope slide, so that only their gilded shells remained. These could then be used as centers for the deposition of further gold from a suitable solution.

The method was next applied to solutions of egg albumen, the particles of which are much too small to be visible even under the ultra-microscope. Nothing was revealed on ashing, but when the invisible gold particles were used as nuclei for the deposition of further gold, it was possible to count accurately the number of albumen particles present in a given volume. The particles of albumen counted in this way were found to consist, on the average, of only fifty chemical molecules apiece.

The same technic was then used to examine filter-passing micro-organisms. Success was claimed, particularly in the case of the bacteriophage discovered some six years ago by the famous French-Canadian bacteriologist, d'Herelle. This bacteriophage is one of the great mysteries of micro-biology. It brings about the destruction of dysentery and other bacilli, but expert opinion is sharply divided as to whether it is a living organism or a ferment. At any rate it is enormously smaller than the bacteria which it attacks.

Prof. Bechold has also attempted to gild the ultra-microscopic virus of smallpox, but so far without success, although he is continuing his experiments. In view of the claim by Dr. W. E. Gye and J. E. Barnard that cancer is due to a filter-passing micro-organism, great interest has been excited by Prof. Bechold's investigations among British cancer research workers.—*Science Service*

Correspondence

To the Editor:

The Journal of Chemical Education for January, 1926, contains a review of Pearson and Hepburn on "Physiological and Clinical Chemistry." Certain statements made in this review are of such a nature that they may not be permitted to pass unnoticed.

The reviewer stresses the absence of a chapter on lipins. According to the 1924 directory of the American Chemical Society, the reviewer is a member of the faculty of the University of Maryland. The medical school of that university is a member of the Association of American Medical Colleges according to the Proceedings of that Association for 1925. Therefore, the reviewer should be familiar with the requirements for entrance into medical colleges as formulated by that Association, and should know that organic chemistry is a required subject for admission. Since the fats, oils, and related compounds are discussed in organic chemistry, a descriptive chapter on lipins was considered unnecessary in a treatise on physiological chemistry.

The reviewer comments adversely on the absence of a bibliography, claiming that collateral reading by the student is thereby discouraged. Now the American Medical Association in its monograph "Choice of a Medical School," 1925 edition, page 11, requires that a medical college "should have a working medical library, to include the more modern text and reference books with the Quarterly Cumulative Index, the Surgeon-General's Index, the Index Medicus, and other serviceable indexes. . ." The collateral reading of the student is encouraged and readily guided by these indexes, *Chemical Abstracts*, and the advice of a competent instructor.

The reviewer claims that many of the tests are antiquated, and that the procedures of other tests are inaccurately described. As stated in the preface, the laboratory procedures have been found reliable by experience. The old tests have stood the test of time. Thus, Fehling's reagent is still official in the methods of the Association of Official Agricultural Chemists and in the Pharmacopoeia of the United States, although devised in the middle of the last century. The procedures are accurately described, and are readily followed by the authors' students, and should be followed readily by any person of the same degree of intellectual development.

The reviewer infers that Trommer's test is chosen as the principal test for reducing sugars, whereas no special stress is placed upon it. His

comment concerning Benedict's qualitative test is academic; Benedict used urine, while the student is directed to use a dextrose solution and a larger volume of reagent.

The reviewer's statement that Gunzberg's test is given second place is incorrect. The reviewer overlooked the direction to the student to repeat the tests for free hydrochloric acid by each of the three methods with several successive dilutions of hydrochloric acid, as high as 1:10,000, and to tabulate the results. The student thereby learns for himself the relative sensitivity of dimethylaminoazobenzene, Gunzberg reagent, and Boas reagent. The reviewer mentions the relative order of presentation of Uffelmann's test and Kelling's test, but he has omitted to state that numerical values are given for the sensitivity of each of the three tests for lactic acid: Uffelmann's, Kelling's, and Strauss'.

The reviewer apparently overlooked the preface, for it is there stated that the course in physiological and clinical chemistry given by the authors is preceded by six collegiate courses in chemistry, including lectures and laboratory work in general inorganic chemistry, qualitative analysis, quantitative analysis, physical chemistry, and organic chemistry. Elaborate statements, definitions, and descriptions, in many instances, would be repetition in view of the students' prior training. The writer has been an abstractor for *Chemical Abstracts* since 1915, and has thereby acquired the ability to state facts concisely. He has made use of this ability in the writing of the book.

The reviewer errs in stating that the polariscope is described on page 65. The polariscope has been described and specific rotation has been discussed in the course in physical chemistry mentioned above. The test to which the reviewer refers is a concise statement concerning the quantitative determination of dextrose and other sugars by the optical method. To the writer, that statement is neither vague nor deficient.

The definition of acidosis as a diminution of the alkalinity of the blood is correct. The statements concerning glycosuria and hyperglycemia are ample, for the treatise does not profess to cover differential diagnosis, therapeutics, and the practice of medicine. Likewise, it does not profess to be a monograph on parasitology, hence the absence of the pictures of the intestinal parasites and their ova.

The claim that the book is defective in matter is the reviewer's individual opinion. Such a claim has not been advanced by other reviewers, men of standing in chemistry and medicine. The claim is refuted by the fact that the book represents the course in physiological and clinical chemistry as given by the authors in this college, whose graduates are admitted to the examination for licensure by the state board of medical examiners of every state in the Union, as well as by the National Board of Medical Examiners. Moreover, all the chapters are based on the personal ex-

perience of the authors in teaching, research, and clinical work for a score of years. Thus, the theoretic portion of the chapter on carbohydrates is based on a paper by the writer which was awarded the Edward Longstreth Medal of Merit by the Franklin Institute. The chapter on enzymes is based in part on the experience of the writer in working in that field in the Food Research Laboratory of the U. S. Bureau of Chemistry, in part on his researches on insectivorous plants which were awarded the Certificate of Merit of the Franklin Institute. The reviewer has overlooked the fact that the book contains standard methods for the analysis of foods, milk, water, and blood, and the recently devised procedures for the determination of urea by means of urease, the colorimetric determination of reducing substances and the nephelometric determination of albumin in the urine, and the determination of neutral fat, fatty acids, and soaps in the feces, as well as discussions of such timely subjects as basal metabolism, cold storage, the separation of the amino acids, and the measurement of liver function.

The writer, as co-author of the book, requests that you give to this letter the same publicity as was accorded the review.

JOSEPH SAMUEL HEPBURN

Hahnemann Medical College,
Philadelphia, Pa.

TO THE EDITOR:

In view of the available good books on Physiological Chemistry and Clinical Chemistry the reviewer sees no reason for the existence of the book discussed immediately above, except for the authors' local use.

H. BOYD WYLIE

University of Maryland
Baltimore, Md.

Secret Metal Test Detects Criminals. A secret process that allows the metallurgist to detect marks on steel that a thief or wrongdoer thinks he has entirely obliterated has been developed as a result of research by metallurgists of the U. S. Bureau of Standards.

The method originated when the experts were asked to study an army pistol with identification number badly mutilated. Through their efforts the weapon was turned into a valuable piece of criminal evidence. The method used has since been employed extensively by police officials.

Details of the process will not be revealed for reasons of public safety but it is explained that it rests upon the fact that metals, generally regarded as dead and inert, are actually alive in the sense that they retain in their internal structure evidence of their past history and experience.—*Science Service*

Chemical Digest

EDITORIAL PARAGRAPHS

The adequate preparation of a sufficient number of teachers to handle efficiently the rapidly expanding program of education presents a problem recently brought to the attention of the public through editorial comment. We quote the following from the *Educational Research Bulletin:*[1]

> No teacher-training institution, however, has yet had the temerity even to claim to turn out a finished product. The best thinkers in this phase of educational endeavor recognize that after the training work has been done in the institution there will continue to be need for additional training in service.....
>
> Many programs, however, which have been attended by our teachers have furnished little that may justly be called additional training. The lectures have been inspirational with little content. That inspiration is important must not be denied, but inspiration which does not suggest something tangible which teachers may do to increase their efficiency and secure better results in their class-rooms when they return to their work is scarcely worth its cost. It bears about the same relationship to genuine training which relish does to the meat course of a feast. We wish our teachers to have developing ideals of professional service, but we maintain that these developing ideals can best be secured by providing our teachers with the means of securing a better educational product from their teaching effort.

Further comment on the same subject appears in a recent number of the *Journal of the National Educational Association:*[2]

> There is no responsibility in the whole range of human life where training counts for more than in teaching. Mere verbal command of book materials is the least of the teacher's tasks. When a community employs a teacher it is buying the moral and mental outlook of its children. It is buying ideals, attitudes, and appreciations that will do more to determine the success of the children than mere mastery of subject-matter. Teaching is a specialized job, as medicine and engineering are specialized jobs. Society would not entrust its health, its huge buildings, or its great bridges to the hands of untrained men. No more should society entrust the welfare of its children to the hands of novices, ignorant of the materials with which they work and the intricate laws that govern human life and social progress.

"Hunger precedes and conditions the real enjoyment of food." Thus, in education, a need for knowledge must be felt before its pursuit can become profitable. The following is quoted from the *Ohio Educational Monthly:*[3]

> We have been confusing knowledge with education for so long, and both with books and apparatus for so long, that we are now in such a maze that men and women are

[1] "Meat or Relish," *Educ. Res. Bull.*, **5**, 76–7 (1926).
[2] "The New Teacher," *J. Natl. Educ. Assoc.*, **15**, 67–8 (1926).
[3] "Needs and Education," *Ohio Educ. Mo.*, **75**, 41–4 (1926).

writing bulky books in which they try to tell us what education really is—and many of these are pitifully inept. In our confusion we are valiant in our efforts to give the child a mass and multitude of general ideas before he has had time and opportunity to acquire that particular observation necessary to interpret these general ideas, and so we burden him with a load for which he is not conscious of any need, or, in other words, we feed him before he is hungry and thus induce indigestion which renders him sluggish and dull.....

We cram the mind of the pupil with what other people say in books and magazines; we surfeit him with what we call facts; we load him down with second-hand, and, often second-rate opinions until his time is so fully taken up with all these multifarious matters that he has no time remaining to formulate sane opinions of his own. Indeed, we are not specially concerned as to what his opinions may be but are prodigiously concerned as to his ability to pass an examination—arbitrary and irrelevant, it may be, but still an examination and, therefore, sacrosanct. He has not lived long enough to have made any particular observation as to these many matters but we still crowd the general ideas upon him willy-nilly and thus disturb the balance. For in all this process which we call education there should be an exact correspondence between all his abstract ideas and the things which he has observed for himself. Otherwise he will have much to unlearn when he has had time for observation and unlearning things is a difficult task and, quite often, impossible.

In the *China Journal of Science & Arts*,[4] we find the following comment:

Without thorough preliminary schooling, training in science is futile. The contention that it begets orderly thinking is not well founded. Rather is it true that, without early inculcation of orderly mental processes, comprehension of science is virtually impossible. Admitting that the scientific bent is a natural gift, which will find expression independently of skilled direction, to assume that there lurks in every individual the spark of scientific achievement, needing but the sight of laboratory equipment to burst into flame is fatuous.

The dictum that the educated man knows something of everything and everything of something, holds today as firmly as ever. Constant recession of the boundaries of every department of knowledge renders it more and more difficult to conform with this definition, thus ostensibly justifying the plea that a lifetime no longer suffices to become acquainted with all there is to know about some one thing. This plea, curiously enough, is advanced chiefly by those to whom the royal road to learning has been revealed and who might, therefore, be expected to have far more time for erudition than the mere plodder along the timeworn path.

Disregard of these principles is responsible, in China, for a unique structure. An ornate and imposing roof intrigues the eye. This is soon seen to be supported by flimsy walls that rest on a shallow foundation. In the anxiety to show results commensurate with the considerable financial investment, quantity production has prevailed over quality. Apparently inspired by the achievement of industrial works capable of turning out a complete locomotive in 24 hours, local schools seem to have adopted the slogan, "a doctor a day," or a chemist, or a biologist, or an engineer as the case may be. An ever-increasing crop of one-sided specialists, suffering the delusion that cerebral eruption and thought are identical, is consequently being harvested.

It behooves those who constantly urge upon China that her salvation is in science, to make clear to her that its comprehension is not bestowed by a wave of harlequin's wand: that scientific achievement is the most arduous of labors and that opportunism and the true scientific spirit are incompatible.

W. R. W.

[4] "Scientific Education in China," *China J. Sci. & Arts*, **4**, 55–6 (1926).

AN EDUCATIONAL PROJECT OF THE SEVENTEENTH CENTURY*

The project to which the title of this paper refers is "A Proposition for the Advancement of Experimental Philosophy" by Abraham Cowley. In introducing his subject, the speaker mentioned, in passing, the possibilities which chemistry holds for influencing the future civilization of the world.

Abraham Cowley, scholar by temperament and a man of letters by preference, indulged his genius intermittently and as chance willed during the troubled period of the civil wars, the rule of Cromwell, and the early years of the restoration. A staunch royalist, he followed the queen-mother to the continent and remained there in her service for twelve years. Later he returned to England as a royal agent and, the better to conceal his real activities, assumed the role of a student of physics. He made dissections, took up the consideration of simples, and composed a poem in six books upon plants and trees. The enforced solitude of these years of hiding strengthened a natural taste for quietude and, on the restoration of the Stuarts, he declined preferment at court and continued his studies and writing in retirement, where his interest in the natural sciences led him to develop a project for an institution of learning very modern in some of its designs.

The college was to be situated no farther than three miles from London for the convenience of auditors who might be attracted thence by the daily or bi-weekly lecture "upon such parts of natural experimental philosophy as the professors shall agree on among themselves, and as each of them shall be able to perform usefully and honorably"—the public lectures which today form part of university extension work.

The college was to be built in "three fair quadrangular courts, and three large grounds, enclosed with good walls behind them." The first court was to be built with a cloister. The second quadrangle was to contain the chapel, school house, library, anatomy chamber, and other academic structures, notable among which was a Hall of Fame, "a gallery to walk in, adorned with the pictures or statues of all the inventors of anything useful to human life;....with short eulogies under the portraitures." The third court was for use and not for beauty and was to contain in addition to the kitchens, butteries, brew-house, etc., "great laboratories for chemical operations and lodgings for the servants." There was to be a botanical garden and in addition a second garden "for the trial of all manner of experiments concerning plants." A third ground was to be "employed in convenient receptacles for all sorts of creatures which the professors shall judge necessary for their more exact search into the nature of animals and the improvement of their uses to us." Here

* Abstract of the address of the past-president at the Annual Meeting of the Nebraska Academy of Science, H. von W. Schulte, May, 1925.

the building program stops, not that the plan was deemed complete, but from the fear that it would be too much "for the charity or generosity of this age to extend to."

The revenue of the college was to be £4000, which was to support "twenty philosophers or professors and sixteen young scholars, servants to the professors," a chaplain, a bailiff, and a variety of employees. The maintenance of the personnel was set as £3285, "so that there remains for keeping of the house and gardens, and operatories, and instruments, and animals, and experiments of all sorts, and all other expenses, seven hundred and fifteen pounds."

One is tempted to comment on the modernity of the distribution of funds—elaborate buildings, very moderately paid staff, and inadequate working budget—but Cowley expected his institution to enrich itself and that the liberality of wealthy benefactors, encouraged by the public benefit which would accrue from his foundation, would supplement the working funds. He could hardly have forseen the American University, which acquiring great wealth, continues to elaborate its plant, leaving salaries and funds for research to be supplied from the leavings of the architect and the athletic department. It may be noted that while there were to be twenty professors, only sixteen servant scholars or *Famuli* were provided. This is accounted for by a provision for "four professors itinerant" to be assigned to the four parts of the world, Europe, Asia, Africa, and America, "there to reside three years at least, and to give an account of all things that belong to learning, and especially natural experimental philosophy of those parts."

Cowley had a four-fold purpose in establishing this institution. He outlined this as: "first to weigh, examine, and prove all things of nature delivered to us by former ages; to detect, explode, and strike a censure through all false moneys with which the world has been paid and cheated so long; and, as I may say, to set the mark of the college upon all true coins, so that they may pass hereafter without any further trial: secondly, to recover the lost inventions, and, as it were, drowned lands of the ancients: thirdly, to prove all arts that we now have; and lastly, to discover others which we have not yet." Cowley feared for his plans; not that he thought a program to advance learning "could check or interfere with any parties in state or religion" but because of its initial expense "being so great, that it may seem hopeless to raise such a sum out of those few relics of human charity and public generosity that are yet remaining in the world."

It is easier to design an instrument of learning than to forsee public opinion; with institutions rich beyond Cowley's fondest dream, we find them hampered by lack of vision and futilities within, and menaced by organized and passionate ignorance from without. The course of history

more than once has shown that chaos may be the precursor of new beauty; we pass, but knowledge and wisdom emerge from our perplexities; and our generation, particularly, can go about its business with fortitude, serene in the confidence that after us shall come, not the deluge, but the Chemist.

W. R. W.

ADDITIONAL ABSTRACTS OF EDUCATIONAL PAPERS DELIVERED AT THE TULSA MEETING OF THE A. C. S.*

Scientific Method in Teaching Chemistry

A. T. LINCOLN

The entities utilized in the methods of science comprise a number of important types of objects which may be classified under the perceptual and the conceptual processes of the scientific method. The procedure of this method comprises the repetition of the cycle consisting of experimentation, codification, generalization, and verification. If science is "a process of rendering primary facts intelligible" then as the basis of the scientific method the electrochemical series of the elements lends itself admirably to presenting the primary facts of chemistry. For by the judicious application and repetition alternately of the perceptual and the conceptual schemes to the electrochemical series, thus developing inductively ever higher and higher concepts, there is obtained a truly scientific method of teaching elementary general chemistry.

A Deviation from the Stereotype Method of Teaching Freshman Chemistry

W. A. FELSING

1. *The Usual Freshman Chemistry Course*

The usual procedure of teaching freshman chemistry in our universities consists of presenting a few basic principles at the beginning of the course. These principles are illustrated usually by "oxidation-reduction" reactions, being presented by chapters on oxygen and hydrogen. At the very beginning of the course, therefore, "oxidation-reduction" reactions are presented. These chapters are usually followed by chapters on atomic weights, their derivation, and use in chemical arithmetic.

The subject-matter thus introduced, either one of two procedures is

* See THIS JOURNAL, **3**, 348–51 (1926).

followed: (1) discussion of the elements by division into two groupings, (*a*) the non-metals and (*b*) the metals, or (2) discussion of the elements by groupings of the periodic classification. Of course, chapters on ionization, battery action, and electrolysis are introduced at various points.

Throughout the course, no separation is made between the ordinary metathetical reactions and the oxidation-reduction reactions. The fundamental principles, by means of which these types of reactions can be judged or predicted, are not specially emphasized, and hence the *average* student fails to grasp the fundamental difference between the forces that bring about metathesis and electronic exchange.

2. *The Proposed Method*

At the University of Texas there has gradually come into use a method of presenting to freshman a course in general inorganic chemistry somewhat different from the usual course.

The general basic principles are presented at the beginning, the illustrations being drawn from metathetical reactions. The concept of a simple change of partners is not difficult. The next step involves the interaction between acids and bases. Ionization and solubility serve to help predict as to "why" or "under what conditions" a metathetical reaction will take place. These predictions are verified by laboratory test-tube trials. The concept of a reversible reaction at equilibrium can well be illustrated by means of metathetical reactions, rather than by oxidation-reduction reactions, mostly used.

The action of general reagents such as NaOH, NH_4OH, and H_2S fits logically into the scheme. This is followed by an intense laboratory course in qualitative analysis. The major portion of the reactions are metathetical. The few oxidation-reduction reactions needed are used, of course, but the writing of the equations is postponed until a later date.

At this point there is introduced the usual Mendelejeff system based upon the findings of atomic structure research. A few typical groupings, such as the carbon, the oxygen, the nitrogen, and the halogen groupings are then discussed, which again enlarges the students' storehouse of facts. Attention is called particularly to the increasing occurrence of oxidation-reduction reactions, and this is followed, as Dr. Lochte will show, by electronic change reactions, such as electrolytic and battery reactions. With this introduction, oxidation-reduction reaction equations follow logically. The "reasons why" or the "conditions under which" it may be predicted that reaction takes place in these cases logically follow. Some descriptive material on metals is usually added here, together with some of the fundamentals of organic compounds.

The Pole Reaction Method of Teaching Oxidation and Reduction Reactions in First-Year Chemistry

H. L. LOCHTE

Inasmuch as oxidation and reduction reactions are electron exchange reactions, it seems only proper that they should be taught as such. A number of schemes using this idea have been proposed. The following method has been in use for freshman classes at the University of Texas for more than 15 years.

The reaction is considered as one involving the loss of one or more electrons by one ion or atom and the gain of an equal number of electrons by another atom or ion. Whether these ions or atoms exist in free and demonstrable form matters not as long as the final product shows that the electron exchange has taken place. The presence of one or more species of other ions may or may not affect the fundamental reaction, but they do not enter into the electron exchange reaction itself. Based on these considerations, all equations are *derived* by the following logical steps.

The two-pole reactions involved are first indicated by equations. These are then balanced to make the number of electrons involved in the two-pole reactions equal. The two-pole equations are then added to yield the equation for the essential or real reaction. Any other ions (other than those from water) present, either accompany the reacting ion or with possible salifying acid, are then added to both sides of the equations and combined to form the final complete equation.

As the steps involved are identical in all cases, students trained in the use of this method are able to derive the equation for any oxidation and reduction reaction, provided the electron exchanges are known or predictable from the relative position of the two poles in the electromotive force table. In this respect the method is equal to any other scheme of writing such equations, the method is consistent throughout, and finally the reactions are taught in a manner that follows logically from modern theories of atomic structure.

A College Course in Quantitative Analysis

MINNIE A. GRAHAM

An outline of an introductory course in quantitative analysis, planned for second-year students who may not be able to give more than one semester to this division of the work. Emphasis is put upon the application of theoretical principles previously studied, careful technic, and efficiency in the use of time. In the laboratory gravimetric and volumetric determinations are carried on at the same time. This arrangement

affords opportunity for the repetition of some important methods of analysis without occasioning monotony and the student's interest is kept throughout the course. This plan has been tried for several years and has given good results in the amount of work accomplished and the ability shown by students to carry on independently the work of more advanced courses.

The High-School Chemistry Club

HAROLD WALKER

1. Purposes of club:
   - *a.* Stimulate the student's interest in chemistry.
   - *b.* Promote the American Chemical Society Essay Contest in the Rapid City High School.
   - *c.* Bring chemistry to the attention of the community.
2. Membership: anyone who has taken or is taking chemistry.
3. Meetings: Once a week at first.
   - *a.* Meetings should be held less often.
   - *b.* The members should do practically all the work.
   - *c.* A constitution and by-laws stimulate interest.
   - *d.* This year the club meets after school, and among other things has a contest in which everybody may participate.
   - *e.* The assessment of dues at the meeting when necessary is regarded as better than a fixed membership fee.
4. The local press is used for publicity. Objectives of the club are being largely attained.
5. Questionnaire sent out and answered by 112 schools shows:
   - *a.* Twenty-three active chemistry clubs.
   - *b.* Forty joint science clubs or clubs in another science than chemistry.
   - *c.* Forty-nine schools have no active science club of any kind.
   - *d.* Twenty of twenty-one discontinued clubs have discontinued because of:
     - (1) Too many outside activities.
     - (2) Lack of interest.
     - (3) Lack of coöperation among teachers.
     - (4) Too social in nature.
   - *e.* Purposes of club stated in questionnaires are:
     - (1) To stimulate interest in chemistry.

(2) To provide additional activities for especially capable chemistry students.
(3) To discuss subjects for which there is not time in class.
(4) To promote better relationship between teacher and pupil.
(5) To arouse community interest in chemistry.

f. Additional facts shown by answers to the questionnaires:

(1) Practically all clubs have constitutions and faculty advisors.
(2) No scholarship requirement for membership in majority of clubs.
(3) Election of officers each semester in majority of clubs.
(4) No regular dues, assessments as needed.
(5) Meetings monthly or semi-monthly in most of the clubs.
(6) Outside speakers, trips, pupil activities, and teacher activity made use of.
(7) Average attendance about 25 to 30 for chemistry clubs and 30 to 35 for science clubs.

g. Most important club problems:

(1) Too many outside activities.
(2) Program making.
(3) To get students to do their part.

h. Means of maintaining interest:

(1) Enthusiastic, capable teacher.
(2) Well-planned programs.
(3) Pupil management, pupil activity.

Laboratory Reports in Beginning Chemistry

LYMAN J. WOOD

I. Introduction.

A. The need of a new system of laboratory reports in beginning chemistry.

B. Daily laboratory reports made on cards bearing initials of instructor which are issued only after both experimental results and note-books have been inspected.

II. Purpose of Requiring Daily Reports.

A. To enable the student to get more from his laboratory work than is generally possible by the usual method.

III. Mechanics of the System.

A. Laboratory results and note-books of each student are inspected after each experiment.

B. If work is found satisfactory a card bearing instructor's initials is issued.

C. On this card is reported a brief statement of the object, results, and conclusions of experiment.

D. Each card is graded and handed back the following day, which would be impossible in the case of the usual note-book.

IV. Advantages Gained.

A. The note-books are kept written up to date in about 98 per cent of the cases.

B. Better note-books are kept since a summary must be placed on the report cards.

C. The student has a daily report of his work.

D. The manner of obtaining the report card has an excellent psychological effect.

E. The pointing out of mistakes is facilitated.

F. The laboratory reports almost of necessity represent actual work done by the student making the report.

G. Less time is required for grading the cards than is required for grading note-books in the usual way.

Search for New Element Described by Discoverer. For the first time in its history, the members of the American Chemical Society were told of the discovery of a new element by one of their fellow members. Prof. B. S. Hopkins, of the University of Illinois, told of his work in collaboration with J. Allen Harris and L. F. Yntema, which recently resulted in Illinium, element No. 61 in the list of the elements, the first to be discovered in the United States.

The element was obtained from monazite, a material used in the manufacture of gas mantles, but it was necessary to repeatedly dissolve and crystallize it to get the portions in which the new element was found. Finally, by photographs made with the aid of X-rays, spectral bands were obtained which corresponded to the missing element, for many of its properties were known long before its discovery. The wave lengths of the lines on the plate were within four twenty-five billionths of an inch of those calculated in advance, said Prof. Hopkins, and though they were faint, their presence was verified by a number of disinterested observers. Doubtful plates were rejected.—*Science Service*

ABSTRACTS

Industrial Alcohol. ANON. *Drug & Chem. Markets*, **18**, 389–90 (1926).—Each year finds more of the pure ethyl alcohol going into denatured alcohol. The use of pure tax-paid ($4.18 per gallon) alcohol has declined from 18,400,000 gallons in 1921 to 4,500,000 gallons in 1925. A total of 87,455,500 gallons was produced in 1925—about 34% coming from Louisiana, 18% from Maryland, and 11% from Pennsylvania. The largest single use for alcohol is as an antifreeze in automobile radiators. Over 28,000,000 gallons were used thus last year. R. A. B.

Market Reactions to Research. ANON. *Drug & Chem. Markets*, **18**, 11–4 (1926).—The term "readjustment" best sums up the situation during 1925. The most foresighted of the manufacturing executives know that they are able to profit most by leading in these readjustments rather than by being lead by them.

New developments of a technical character—bromine, ammonia and its salts, methanol, butanol, and acetic acid, are familiar examples—have had serious effects upon supply, felt in price revisions. New demands in artificial silk and leather, in lacquers, in motor fuels, in rubber accelerators, have dug new consuming channels through which many supplies have been diverted. Control of raw material supplies—quicksilver, vanillas, and peppermint oil for example—have affected markets markedly. New products, such as synthetic menthol, and new producers, as in quinine and acetic anhydride, have forced readjustments. R. A. B.

The Future of Chemical Fibers. ANON. *Drug & Chem. Markets*, **17**, 911–2 (1925).—The chemical industries look upon the expansion in artificial silk production with the feeling that in time it may be the greatest of all consumers of chemicals. The manufacture of rayon fibers now requires huge quantities of caustic soda, denatured alcohol, carbon disulfide, sulfuric, nitric, and acetic acids, ammonia, copper oxide, sulfur chloride, acetone, sodium disulfite, tetrachloroethane, innumerable dyes, and other products in lesser amounts. Of the 70 plants now producing artificial silk, 15 are in the United States, 20 in France, 6 in Great Britain, 12 in Germany, and 6 in Switzerland. There are about 50 additional plants under construction at the present time—10 of them in the United States. The combined production for all these plants during 1926 is expected to be around 300,000,000 pounds. The two chief raw materials for rayon are wood pulp and cotton linters—the latter being preferred. R. A. B.

The Expansion of Vanillin Consumption. L. A. WATTS. *Drug & Chem. Markets*, **17**, 1119–20 (1925).—An interesting description of the history of the production and use of vanilla. Eighteen manufacturers of vanillin exist throughout the world. Of these firms, thirteen use oil of cloves as the raw material, three use guaiacol, one both clove oil and guaiacol, and one synthetic eugenol. The manufacturers are distributed by countries as follows: United States, 4; Great Britain, 2; Germany, 4; Switzerland, 3; Austria, 1. The annual production of vanillin in the United States is approximately 125,000 pounds. From a chemical curiosity some years ago, it has become what is perhaps the most widely used synthetic flavoring material in the world. R. A. B.

Why Inventions Play a Vital Part in Investment Values. ANON. *Mag. of Wall Street*, **37**, 610–1 (1926).—"The research activity of a company is a guide to the investment value of its securities . . . . . It tests not only the aggressiveness and foresight of the management, but also the prospects of an entire industry."

Among the leading companies in the field of research are mentioned: Allied Chemical & Dye Corpn., du Pont Co., Eastman Kodak Co., General Electric Co., Goodyear Tire Co., New Jersey Zinc Co., Pennsylvania R. R., U. S. Industrial Alcohol Co., Western Electric Co., and Westinghouse.

While some industries are suddenly faced with the necessity of developing research by a change of conditions, such as confronted the phonograph industry when radio competition arose in a market already overloaded with inventions, other industries are permanently faced with research problems. Such are the manufacture of electrical equipment, the chemical industries as a whole, the paint and varnish, fertilizer, textile, and many other industries, in which constant technical improvement of processes and the search for new markets are essential to survival as well as progress. The amount of progressive technical work which is being done by, or for a company cannot be judged by the size of its laboratory or of its research staff. Many companies collaborate closely with outside institutions, such as laboratories of other companies, of endowed institutions like universities, or groups like the National Research Council. The indifference to research as being "high-brow" or academic is disappearing rapidly from industrial circles. W. R. W.

Freezing Points. FOOTE AND LEOPOLD. *Am. J. Sci.*, **11**, 44–6 (1926).—Air which is dissolved in a liquid affects its freezing point. The effect may be as much as 0.03°

in the case of some pure solvents. It is suggested that the freezing point of a substance be defined as the temperature at which the solid and liquid are in equilibrium when saturated with dry air at a pressure of one atmosphere. The values for the freezing points would then be comparable. The effect seems to be greater in organic than inorganic liquids. G. B. HEISIG

Elimination of Salt from Sea-Water Ice. W. G. WHITMAN. *Am. J. Sci.*, **11**, 126–32 (1926).—Dr. Vilhjalmur Stefansson observed that sea-water ice only a few days old is too salty for cooking or drinking purposes; whereas, ice that has floated in the ocean during the warm season is palatable, though somewhat brackish; and ice which has floated for 2 or 3 seasons contains less salt than ordinary river water. This phenomenon may be explained by assuming that small droplets of brine are dispersed throughout the sea-water ice. If one of these droplets is considered, some of the ice surrounding it on the warm side will melt to establish equilibrium. The concentration of the salt in the entire droplet would be reduced by diffusion, and more ice would be formed at the colder part of the droplet in order to increase the concentration so that equilibrium might be reached. The net result would be the movement of the droplet of brine toward the warmer part of the ice. Experimental evidence is given substantiating the above theory. G. B. HEISIG

The Senate of Chemical Education. EDITORIAL. *Chem. Bull.*, **13**, 45 (1926).—After indicating the personnel of the senate, its purpose is given: "to foster and guide chemical education." The hope is expressed that it can weld the interests of high-school, industrial, and college chemistry "so they will function as one."

The high-school teacher is characterized as in a large degree responsible for developing "appreciation for chemical knowledge and the services of the chemist."

"The college or university teacher has the opportunity to prepare teachers." Perhaps attention might first be centered upon improving the teachers in secondary schools. B. C. H.

"Nomag" Non-Magnetic Cast Iron. S. E. DAWSON. *Inco*, **6**, 10–1 (1926).—In the past the ingredient of iron receiving most attention has been carbon. More recently other alloying elements for iron have been studied and this article considers especially the influence of nickel and manganese with the production of Nomag, a non-magnetic high resistance cast iron.

Iron exists in several allotropic forms limited by differences of temperature and influenced by "foreign" elements. These forms are commonly limited to gamma iron above 900°C.; beta iron and alpha iron below 780°C.

These different forms of iron have different electrical and magnetic properties, and to retain certain properties it is necessary to keep the iron in that allotropic state. The gamma iron is non-magnetic but it loses this property when cooled below 900°C.

Carbon in iron when present to 0.25% will lower the transition point between gamma and beta iron from 900°C. to 760°C. Nickel added to low carbon steel will produce non-magnetic gamma iron stable at ordinary temperatures if as much as 25% is added. Manganese will produce the same result for low carbon steel if but 12% is added.

Test shows that the magnetic permeability of ordinary cast iron is practically 300 times that of Nomag and that the specific resistance of Nomag is almost twice that of ordinary cast iron. B. C. H.

Letter to High-School Teacher from Former College Professor. ANON. *Chem. Bull.*, **13**, 42–3 (1926).—The "Professor" shows his bias in the first paragraph when he exclaims, "I hate educators with a deadly hate."

He confesses, however, that students who come to college with high-school chemistry "made a better showing in the University than those who have not had high-school chemistry." This he explains as due to these students' greater inherent interest in science and to advance knowledge of what college chemistry is to be like.

His advice as to content is "Take a good elementary text-book—and go *half way* through it in a year." With this he would commend, "the solution of a host of simple arithmetic problems (for the application of theory.)" He would have two classes in chemistry, one for prospective college students and another for all others, those who would like to "think chemistry a tea party."

He asks that the chemistry teacher "know his subject thoroughly, not advanced chemistry necessarily but general chemistry, and have a personality that will hold attention so that he can put his knowledge over . . . . he needs to know little theory of teaching, but he must know how to keep order and hold attention." B. C. H.

Oil and Gas as Domestic Fuel. JOHN T. WARD. *Tech. Rev.*, **28**, 141 (1926).—Gas and oil fuel for domestic heating must be classed as luxury fuels, although both may

be used more efficiently than coal, John T. Ward, Assistant Professor of Chemical Engineering, Massachusetts Institute of Technology, told members of the Rochester Section of the American Chemical Society in an address some weeks ago.

Professor Ward discussed and illustrated the theories now held as best explaining the chemical processes which occur during the combustion of fuel oil and showed the more important types of domestic burners. He said that the increased use of oil and gas was due to the desire for "automatic clean heat."

The point was emphasized that the considerations which should govern the choice of an oil burner were, in order, safety, reliability, convenience, cleanliness, and burner cost. Gas-fired boilers rate highest in efficiency, 80–85%, whereas the usual maximum for oil-fired heaters is 70% and the average efficiency of an anthracite-fired coal heater is 50–55%.

He stated that it usually costs twice as much to heat a house by gas as by coal, while oil fuel costs half as much again as coal used in the same heater. S. W. H.

Chemical Program at Conference of Institute of Politics, Williamstown, Mass. ANON. *Tech. Rev.*, **28,** 70 (1925).—Chemistry's influence in modern civilization will be one of the leading topics of discussion in the conference of the Institute of Politics at Williamstown, Mass., next year.

"The Role of Chemistry in the Future Affairs of the World" has been chosen by the board of advisors of the Institute of Politics as the central theme for the discussions which will be organized by the American Chemical Society.

In 1923 considerable attention was given at the Institute of Politics to natural resources; rubber and nitrates obtaining special mention. In 1925 mineral resources proved of interest. In 1926 it is proposed to discuss such important topics as future food supplies, energy—present and future sources and their utilization—chemistry in conservation, stressing wastes in industry and increased efficiency in production, synthetic versus natural products, chemical developments in their relation to labor, chemistry in world domination through commerce, and in national defence and the relation of chemistry to world health. S. W. H.

Kaolin Discovered in Vermont. ANON. *Tech. Rev.*, **28,** 14 (1925).—Kaolin has been discovered on a farm in the Green Mountains near Bennington, Vermont. The deposit is expected to yield more than 1,000,000 tons of clay superior in quality to that now being used in the manufacture of paper.

The deposit has an average depth of twelve feet and lies two miles from Bennington in a valley a mile and a half long. Clay from this valley was used by the potters of the village as early as 1851, when the manufacture of pottery was one of the leading industries of the town. It was not until recently, however, that the true value of the clay was discovered.

This clay, Professor Wm. F. Jones, who has examined the deposit for the owners, says, contains a surprisingly small amount of grit or sand and the separation of clay and grit by machine methods will be simple owing to texture, without any considerable loss. S. W. H.

Pigment Colors vs. Coal Tar Dyes. ANON. *Dyestuffs*, **27,** 14 (1926).—Pigments possess better fastness, are generally cheaper, make the paper soft and bulky which causes a decided loss in strength for products like wrapping paper but ideal in making blotters. The pigments are more difficult to handle, may sometimes rub off and cannot be used for very high finish. T. G. T.

Wall-Paper Has Lengthy History. ANON. *Dyestuffs*, **27,** 15 (1926).—Henry IV of France granted a charter to a guild of paper hangers in 1599. "Wall-paper was a logical development from tapestry and embossed leather wall hangings, through the intermediary stage of painted canvas cloths made in imitation of the richer materials." Chinese wall-paper was imported by the East India Co. in the 17th century which ran a close race with paper manufactured in Germany. T. G. T.

X-Ray Analysis of Organic Compounds. G. SHEARER. *Science Progress*, **20,** 450–60.—A resumé. T. G. T.

Passivity, Catalytic Action, and Other Phenomena. A. S. RUSSELL. *Nature*, **117,** 47–8 (1926).—Some metals are potentially able to exist in both active and passive forms, one of which is stable; thus manganese and iron are normally in the active form and nickel and platinum in the passive form. They are best able to adsorb gases and to act as catalysts when in the passive form. They adsorb, because of their property of never being electrically neutral, a molecule which is capable of exhibiting polarity, the negative part of the molecule being attracted to the outside and the positive to the inside of the molecule. They catalyze a reaction because of their potentiality of passing from the passive to the active form. Examples are given. H. K. M.

X-Rays in Industry. G. W. C. KAYE. *Nature*, **117**, 123–6 (1926).—Condensed from a public lecture delivered at the University of Leeds, setting forth in a clear and concise manner the progress of X-ray investigation and application. H. K. M.

The Transmutation of Elements. A. C. DAVIES AND F. HORTON. *Nature*, **117**, 152 (1926).—D. and H. review the results of attempts at transmutation of elements which have been recently recorded in the light of the two alternative possibilities—the efforts which have been designed to facilitate the entry of an electron into the nucleus and those that try to bring about a transmutation by the ejection of a proton or an α-particle from the nucleus. It appears that the most hopeful method of obtaining evidence as to the exact nature of transmutations is from attempts to detect the lighter products as well as the heavier products of possible transmutations. H. K. M.

The Art of Examination. A. LAWRENCE LOWELL. *Atlantic Mo.*, **127**, 58–66 (1926).—L. discusses three distinct objects of the examination, *viz.*, to measure the progress of pupils; as a direct means of education; to set a standard for achievement. One of our difficulties has come from paying almost exclusive attention to the first of these objects. Examinations designed principally to measure proficiency are exposed to the following dangers: difference of opinion of examiners as to relative importance of subject-matter, nature of questions asked, and the tendency to give back to the instructor what he has given them. Questions should be so framed that mere diligence without a high degree of capacity would not earn the highest grade. L. contends that if the examination marks do not measure accurately the comprehension of the subject-matter as taught in the course and the power to handle it the instructor is at fault. As a direct means of education L. points out, that the examination should determine to what extent the pupils can apply principles to new and unexpected conditions. It should compel the student to reflect upon all that the course has covered and give him a better conception than he would otherwise have of its scope and meaning. The third object, to set a standard of achievement, L. considers most important. To be proficient in anything a man must have a standard and occasionally measure himself thereby. Experience shows that college students, and, no doubt, schoolboys also, will soon rise to any reasonable standard required of them. Mastery of a subject depends on interest, but interest grows with mastery and with the personal exertion to acquire it, while both are aroused by the demand of the standard. The conclusion is drawn that examinations properly used are a vital part of the educational process, but that the art of using them to produce the best results is highly complex and difficult. They should be entrusted to mature teachers who appreciate their values and have experience in preparing them. G. W. S.

Transmutation of Elements. A. SMITS. *Nature*, **117**, 13 (1926).—The quartz-lead lamp is illustrated and described in detail. The use of a mercury air pump and a mercury manometer are avoided. All the materials, examined spectroscopically, were shown to be completely free from mercury and thallium. A high current density is favorable to the transmutation of lead. At make the current was 60–100 amp. and since last contact is made by a very thin spout of liquid lead the current density was exceedingly high. The spectra of lead with comparison spectra of mercury are given at the beginning, after burning half an hour, after $2^3/_4$ hours, after $8^3/_4$ hours, after 12 hours, and after 39 hours. The lead lines gradually disappear and the mercury lines become stronger. As a second method for the transmutation of lead, sparks at a voltage of 1,000,000 volts and 2 milliamperes were sent through the liquid containing lead electrodes for 12 hours. The dispersed lead obtained by the sparking showed a very distinct mercury reaction (formation of HgI_2 by method of Jannash). H. K. M.

The Occurrence of Dwi-Manganese (At. No. 75) in Manganese Salts. J. HEYROVSKY. *Nature*, **117**, 16 (1925). Ditto. G. DRUCE. *Nature*, **117**, 16 (1925).—Two letters in reply to letter of Mr. A. N. Campbell in which he criticizes H.'s original letter under the above title. H. points out that C. shows a misunderstanding of what the polarographic-electro-analysis with the dropping mercury cathode really means. C. is referred to the 17 papers dealing with this special electrolysis already published in English and particularly to the Brauner jubilee number of the *Rec. Trav. Ch. Pays-Bas*, **44**, 488–680. H. K. M.

Science Tests: The New Type versus the Old Type. LEIGHTON K. SMITH. *Sch. Sci. Math.*, **26**, 49–52 (1926).—"The old type test is far from accurate, therefore unscientific." In the oral quiz teachers give hints, offer suggestions, ask leading questions, etc., and finally extract some sort of reply termed a recitation. Students' physical appearance, interest, attitude, etc., influence judgment of his work. Formal written test fails often, in that handwriting influences correction, that insufficient attention is paid to relative importance and arrangement of questions, to proper evaluation of questions

and parts of questions; that questions are based too much on memory and too little on thought, that too much time is spent in writing instead of thinking, and that large variations occur when same paper is graded by same teacher on different occasions.

New type tests eliminate these difficulties but lack the one outstanding value of old type test—necessity student faces in organizing material with no direct hint as to answer. The new type tests are objective, measure some definite trait or degree of achievement, give more definite meaning to marks, are usually constructed upon the judgment of the group, and the mechanics of answering are simple. The better known tests have median scores computed from many pupils in different classes, systems, sections of the country, etc.

Such tests are objectionable in that they demand no organization of material, are an item of expense in that each pupil must have a prepared form, etc.; but are valuable in that they aid in scientific grading and yield information to aid in improving work.

"The conservative, progressive teacher surely will avail himself of their use and by a combination of the two types be able to arrive at a more accurate conclusion of results obtained by students." BEN. H. BALL

How to Get a Closer Relationship between the Chemistry of High School and College. E. H. WESTLUND. *Sch. Sci. Math.*, **26**, 44–9 (1926).—A brief statement of the organization of the chemistry course of the Decatur (Ill.) High School and a summary of 13 replies to a questionnaire sent to 20 universities and colleges. It is concluded that colleges are recognizing work in high-school chemistry, that thorough methods of presentation must be developed to insure closer relationship, that students trained by thorough methods may continue chemistry in college with little repetition and apart from students who have not had high-school chemistry, and that on such a basis the colleges can build courses that will hold the enthusiasm and interest of well-trained students. BEN. H. BALL

Artificial Silk. ELIZABETH WEIRICK. *Sch. Sci. Math.*, **26**, 72–8 (1926).—A brief statement of the conditions creating the demand for artificial silk with an outline of the development of the four processes now in use in manufacturing artificial silk, or as rechristened, rayon. Statistics of production, general properties, uses, etc., are given. BEN. H. BALL

The Scientific Background of Baking. C. B. MORRISON. *Sch. Sci. Math.*, **26**, 79–85 (1926).—A brief history of baking and its development into a scientific industry with an outline of the courses given by the American Institute of Baking (Chicago, Illinois), to the managing and production personnel of the industry. BEN. H. BALL

New Norms for Iowa Placement Tests. GEORGE D. STODDARD. Published by Extension Division of the University of Iowa, **1926**. Mimeograph sheets.—Norms for chemistry aptitude include results from eighteen colleges and for 2032 students. Each college is listed with the number of students, the mean, the median, upper quartile, and lower quartile.

Norms for chemistry training represent returns from twelve colleges and for 1140 students. Norms are given in form similar to those for aptitude. B. C. HENDRICKS

On the Separation of Crystalloids from One Another by Dialysis. LOUIS KAHLENBERG. *Phil. Mag.*, 7th series, **1**, 385–94 (1926).—Crystalline substances may be separated from one another by dialysis with suitable membranes and solutions. Conditions may be arranged so that the colloid passes through the membrane while the crystalloid remains behind. A rubber-dam membrane, material commonly used by dentists, was utilized. After testing a large number of liquids, pyridine was selected as the solvent because it was absorbed by the rubber and also due to the fact that a large number of substances were soluble in it. Substances soluble in pyridine and hydrocarbons would pass through the membrane, while substances soluble in pyridine and water would not pass. Separations by dialysis were made of sulfur from sugar; naphthalene from sugar; sulfur from silver nitrate; naphthalene from silver nitrate; camphor from lithium chloride, etc.

With aqueous solutions, urea was separated from sugars by means of the copper ferrocyanide membrane, the urea readily passing through the septum.

Lanoline, the fat of the wool of the sheep, after overcoming many difficulties was so arranged that it could be used as a membrane. This was accomplished by impregnating silk with lanoline. Urea, sodium chloride, boric acid, and borax readily pass through this membrane. Lanoline is distinguished from other fats by the fact that it is very rich in cholesterine. As the latter substance is "present in all living cells, it would seem likely that it is extremely delicate films of these sterenes that give living cells their wonderful selective osmotic pressures." T. G. T.

The Solubility of Hydrogen in Tin and Aluminium at High Temperatures. L. L.

BIRCUMSHAW. *Phil. Mag.*, 7th series, **1**, 510–22 (1926).—A small but definite solubility of hydrogen in tin has been noted at 800°C. Aluminium at a temperature just above its melting point dissolves considerable quantity of hydrogen. T. G. T.

Models of Electron Structure, Quantum Action, and the Gravitational Field. W. M. THORNTON. *Phil. Mag.*, 7th series, **1**, 13–31 (1926).—The article is illustrated with a number of diagrams and discusses a number of facts related to electron structure and quantum action. T. G. T.

Visual Education in an Industrial School. M. C. KENT. *Educ. Screen*, 141–5 (1926).—In connection with an interesting article on the use of slides and films as aids to instruction in science, the author appends a list of some 57 films suitable and available for such use, together with the sources from which the films may be obtained. The list includes many highly interesting subjects and the films might conceivably be of use to many teachers of chemistry. A few of the titles, selected at random, follow: "Chemical Inspiration," "The Chemist Makes War," "The Story of Coal," "The Romance of Glass," "The Story of Sulfur," "The Story of Asbestos," "The Story of Bakelite," "Liquid Air," "The Science of a Soap Bubble," "Chemical Combustion," "Manufacture of Turpentine," "Refining of Gasoline," "Pillars of Salt," etc. A. P. B.

From Slave to Scientist. EDITORIAL. *J. of Educ.*, **103**, 236 (1926).—A reprint, with comments, of an article from the *Pittsburgh Press* on the life and work of Dr. Geo. W. Carver, head of the research department of the Tuskegee Normal and Industrial Institute of Alabama. Born a slave, unable to read or write at twenty, later an honor graduate of Iowa State College, Dr. Carver is now devoting his time to the preparation of commercial by-products of the sweet potato and peanut. His work is briefly reviewed. A. P. B.

Thirty-Second Annual Report of the Committee on Atomic Weights. Determinations Published during 1925. G. P. BAXTER. *J. A. C. S.*, **48**, 541–52 (1926).—Work on the following elements was published during 1925: He, B, C, O_2, Al, Si, Cl_2, Cu, Ge, Br, Sb, Ho, Hf, Au, Pb. A few of the determinations are of particular interest. Harkins and Jenkins, by diffusion of HCl, have prepared chlorine of atomic weight 35.418. Honigschmidt and Zintl prepared hafnium bromide from hafnium potassium bromide which had been purified by 5000 crystallizations. The atomic weight of hafnium reported by them is 178.57. The same authors have compared solutions of weighed amounts of the chloride of ordinary and "artificial" gold (Miethe and Stammreich) by electrometric methods. No difference could be detected. Gleditsch, Dorenfeldt & Berg obtain from Norway clevite a uranium lead of atomic weight 206.17. Piutti and Migliacci obtain a lead from Vesuvian cotunite of atomic weight 207.05. A. P. B.

The Atomic Weight of Uranium Lead and the Age of an Especially Ancient Uraninite. T. W. RICHARDS AND L. P. HALL. *J. A. C. S.*, **48**, 704–8 (1926).—A specimen of uranium lead from the Black Hills, South Dakota, was found to have an atomic weight of 206.07. Correction for known thorium content on the assumption of accepted inferences concerning thorium would reduce this value to 206.02. Since the lead in question was a nearly pure uranium lead, and since the lead-uranium ratio is found to be the unusually high figure of 0.23, an age of at least 1,500,000,000 years must be assigned to the earth's crust. The greatest previous estimate of the kind, based on certain Canadian rocks, was of the order of 1,200,000,000 years. A. P. B.

The Use of Subscript and Superscript Exponents in Chemistry. E. Q. ADAMS. *J. A. C. S.*, **48**, 708–9 (1926).—Subscripts and superscripts are used in logic, in algebra, and in higher mathematics in a manner consistent enough to permit the generalization that subscripts are used to designate the various numbers of a series or group of related symbols; superscripts are used to denote the same operation as would be represented by the repetition of the symbol to which the superscript exponent belongs, as many times as the exponent indicates. Using this sytem water would be written H^2O and Li_4 and Li_7 would represent two different species of the element lithium. With different isotopes of an element in the same compound, the need for some such system is rapidly becoming felt. As an example, a molecule of phosphorus pentachloride containing three atoms of the chlorine isotope of atomic weight 35 and two of atomic weight 37 would be written $PCl^3_{35}\ Cl^2_{37}$. A. P. B.

Keeping Pace with the Advancing Curriculum. JOHN K. NORTON. *Res. Bull. Natl. Educ. Assoc.*, **3**, 1–102 (1926).—The function of the school is to provide training in the fundamental processes and to train pupils for complete living. This larger function of the school requires continuous attention to curriculum revision. The problems of curriculum revision are affected by rapidity of changes in, and the complexity of modern life; increases in school attendance and pupil heterogeneity; and the advances in educa-

tional science and psychology. The bulletin lists, discusses, and contrasts the educational theories affecting curriculum building and defines seven approaches to the problem. This is followed by an outline of a method for launching a program of curriculum revision and construction. The contributions of research to curriculum building are then reviewed. These include studies in handwriting, arithmetic, spelling, reading, language and grammar, geography, history, civics, health and physical education, and music. Those who have not kept in touch with research of this kind will get from the reviews of these studies a clarification of the modern point of view. There is included in the bulletin a very complete bibliography of books dealing with general curricular problems and with each of the subjects of the secondary school. There is also a bibliography of elementary courses of study published by state and city school systems since January 1, 1923. S. R. POWERS

The New Teacher. EDITORIAL. *J. Natl. Educ. Assoc.*, **15**, 67–8 (1926).—Professional associations are insisting on professional teachers. The best talent is needed; and education could learn much from the system followed by the Army and Navy. West Point and Annapolis are composed of picked men who receive pay while training in order to supply competent officers for our fighting forces. Why not use the same system for training of the nation's teachers? The teacher's standard of living should be increased. No teacher can render full service with constant fear of dismissal for unjust charges. T. G. T.

Teach Them How to Save Their Sight. KIRK M. REID. *J. Natl. Educ. Assoc.*, **15**, 71–3 (1926).—An excellent article which should be read in full by all teachers, particularly those in the secondary schools. T. G. T.

On the δ-Rays Produced by α Particles in Different Gases. J. CHADWICK. *Phil. Mag.*, 7th series, **1**, 1–12 (1926).—Using hydrogen, argon, helium, and air in a Wilson Expansion Chamber, the tracks of α particles were photographed. δ-Rays were produced along them. It is concluded that δ-rays arise from the collision of the α particle with an electron in the atoms through which it passes. To observe the δ-rays sufficient energy must be imparted so as to clear the main α-ray column. T. G. T.

Why Colleges? EDITORIAL. *Colliers*, **27**, 20 (1926).—"While some of our serious thinkers are lambasting the colleges it is profitable to remember that most of the profound changes in our daily life had their inception in college laboratories.

"Fifty years ago college professors were still making experiments and learning the principles out of which electricity, light and power, the telephone, the radio, the automobile, the airplane—and much else developed.

"Those who want to understand what the future may hold should examine the lines along which the research men are now at work." J. W. HOWARD

Teach the Engineer to Write. H. H. HIGBIE. *Wiley Bull.*, Feb., **1926**.—"Great as are the needs of practising engineers for clear-cut and concise professional papers, of college students for text-books which are understandable as well as authoritative, and of publishers for grist for their mill, there are many other reasons, of a nature distinctly more intimate and personal to the individual, why colleges of engineering should devote much more attention than they do to the development of writing ability among their students."

Throughout the development of civilization, language has been not only the essential vehicle but also the greatest stimulant for thought. Clothing our thoughts with language not only clarifies and correlates the thoughts but often improves the imagery which makes them admirable and attractive. The author suggests that the capable teacher who can make matters clear to his students, with the least effort on their part, is not their best friend but rather their worst enemy. A great deal of benefit was derived from the attempt to write up some useful notes from poor lectures. As a teacher, the author made it a practice to require in laboratory courses a written report in which stress was laid not entirely upon descriptions of machines and tests, etc., but quite as much upon the written expression of the student's personality as displayed in an original discussion of the significance of the work and its results.

"The writing out of one's thoughts, like the drawing of detailed plans, compels one to analyze, organize, and fit ideas together and thus minimize or prevent the fumbling that might otherwise characterize almost any unusual operation. Writing upon serious subjects, especially if in competition or under surveillance of a competent preceptor, cannot be excelled as training for orderly and efficient thinking, nor as a means to create standards and pride of workmanship in the student mind. A student should be led to appreciate the satisfaction that may come from having his work so highly regarded by those competent to judge that they recognize it without a signature, and nothing lends itself better to this than personality in writing." W. R. W.

Local Activities and Opportunities

University of Wisconsin. Five young men completed the requirements for the degree of doctor of philosophy, at the University of Wisconsin with the close of the past semester. The recipients of the degree together with thesis titles are as follows: Ellery H. Harvey, "A Study of Sulfur Chlorides and Their Various Fatty Oils;" R. N. Traxler, "The Osmotic Permeability of Plant Membranes;" V. W. Meloche, "A Study of Telluric Acid, Allotelluric Acid, and Potassium Tellurate;" A. J. Stamm, "A Study of Distribution of Size of Particles in Emulsion Systems and Its Relation to Emulsification;" and S. J. Dickinson, "A Study of the Action of Selenium Oxychloride on Benzene and Toluene."

Columbia University. Dr. Henry C. Sherman, professor of chemistry, Columbia University, lectured on "Recent Advances in the Chemistry of Nutrition," at the University of Delaware, February 16th; to the Science Teachers' Association of Washington, D. C., February 17th; at the University of Virginia, February 18th; and to the Richmond Section of the A. C. S., February 19th. Dr. Sherman lectured on "Chemistry as a Profession" at the Vassar College Vocational Conference, on February 27th, at Poughkeepsie.

Friends of Professor Chandler presented in 1920 to the Trustees of Columbia University a sum of money which constitutes the Charles Frederick Chandler Foundation. The income from this fund is used to provide a lecture by an eminent chemist and to provide a medal to be presented to the lecturer in further recognition of his achievements in science. Previous lecturers under this foundation were:

L. H. Baekeland, D.Sc.
W. F. Hildebrand, Ph.D.
W. R. Whitney, Ph.D.
F. Gowland Hopkins, Ph.D.
Edgar F. Smith, Ph.D.
Robert E. Swain, Ph.D.
E. C. Kendall, Ph.D.

The lecturer for 1926 will be Samuel W. Parr, professor of chemistry at the University of Illinois. Dr. Parr's subject will be "The Constitution of Coal."

The lecture will be in Havemeyer Hall, Columbia University, on Friday, April 23rd, at 8.15.

University of Pittsburgh. Professor Alexander Silverman, head of the department of chemistry, University of Pittsburgh, Pa., delivered an illustrated lecture on "Glass" before the Rochester Section of the American Chemical Society in the State Street Auditorium of the Eastman Kodak Company, Rochester, N. Y., Monday, March 1st.

Carnegie Institute of Technology. Courses in chemistry, it is announced, are included in the program for the Summer Session this year at the Carnegie Institute of Technology in Pittsburgh. According to the announcement, the chemistry group, consisting of eight weeks' courses, will be given by the College of Engineering from June 14th to August 6th, and will include general chemistry, advanced general chemistry, and qualitative analysis.

Other courses of interest offered by other departments are physics, mechanics, English, history, economics, commercial law, mathematics, psychology, engineering drawing, plumbing, welding, sheet metal work, machine practice, woodworking and cabinet-making, electric wiring, radio, architecture, surveying, and courses for teachers and supervisors of music, fine and applied arts, and manual and industrial arts.

Colorado School of Mines. The Colorado School of Mines offers fellowships in mining, metallurgical, geological, petroleum, and chemical research.

These fellowships are open to university, college, and technical graduates who are qualified to engage in research work. The value of each fellowship is $675 per year, payable in nine monthly installments. Fellows are exempt from tuition fees, but not from matriculation, graduation, student, and laboratory fees. Appointments to these fellowships are made for a period of one academic year, beginning on September 1st. Applications must be made before May first, and announcements of appointments will be made on or before June 15th.

During the college year fellows are required to devote eighteen hours a week to the school as laboratory assistants, or to such other work as may be assigned to them. During the remainder of their time they may pursue advanced studies and become candidates for higher degrees, or they may engage in research work. The purpose of these fellowships is to induce competent men to undertake the solution of problems in mining, metallurgy, metallurgical chemistry, petroleum, and geology which are of special importance to the state of Colorado.

Applicants should send a copy of their collegiate records from the Registrar's office of the college where they have been, or will be, graduated. They should also state their experience and give the names and addresses of at least three persons who are familiar with their character, training, and ability. Applications or requests for additional information should be addressed to M. F. Coolbaugh, President, Colorado School of Mines, Golden, Colorado.

K. A. C. P. G. S. T. The second annual meeting of the Kansas Association of Chemistry, Physics, and General Science Teachers was held at Topeka, February 6th, in connection with the Council of Administration. The program consisted of a report from the chairmen of the chemistry, physics, and general science round-table discussions of each sectional meeting of the Kansas State Teachers' Association; a discussion of "What Shall Be My Program for the Teachers' Meeting Next Fall?"; addresses from representatives for the teacher-training institutions on "What Should Be the Aims of the Teachers of Chemistry, Physics, and General Science?"; and addresses from representatives of superintendents and principals of the Kansas high schools on "What I Expect from My Science Teachers."

It was moved and passed that the secretary collect the notes and outlines of the speeches from the several speakers and condense these into a presentable form and print them and mail one to each chemistry, physics, and general science teacher in the state. It was voted to have the present officers continue to serve for another year. These are: President, J. A. Yates, K. S. T. C., Pittsburgh; Vice President, Knute O. Broady, Sylvan Grove; Secretary-Treasurer, Ray McClellen, Highland College, Highland.

Harvard University. A new professorship in chemistry, to be called the Theodore William Richards professorship of chemistry, has been established by the gift of Thomas W. Lamont, Harvard '92, in honor of Professor Richards, now Ewing professor of chemistry at Harvard. Professor Gregory P. Baxter is to be the first occupant of the new chair.

A second new chair in chemistry, to be called the Sheldon Emery professorship of organic chemistry, has been created at Harvard and Professor Arthur B. Lamb, director of the chemical laboratory, a graduate of Tufts who secured his master's and doctor's degrees at Harvard in 1903 and 1904, is named the first incumbent of the chair.

N. E. A. C. T. The New England Association of Chemistry Teachers will hold its hundredth meeting on May 1st at Boston College. As this is an unusual occasion, the Committee of Arrangements has prepared a program of uncommon interest.

On Friday evening preceding the meeting, a banquet for members of the Association and friends will be held at a place centrally located in Boston. The banquet price has been fixed at two dollars. The chief speaker at the postprandial exercises will be Dr. James F. Norris, president of the American Chemical Society, and other speakers of note will deliver brief remarks.

The following program will be given Saturday, May 1st: Address of Welcome by the President of the College; Dr. C. E. Bolser of Dartmouth College will speak on "Some Contributions of Chemistry to Medicine;" Rev. J. A. Brosnan will speak on "Color Photography to Date" and will illustrate his remarks with slides, specimens, and a moving picture in the natural colors of a volcano in eruption; Dr. H. F. Davison of Brown University will speak on "New Lecture-Table Demonstrations," illustrating his remarks with the demonstration of new apparatus.

Members of the Association and their families and friends will be the guests of the College at luncheon. For the afternoon, the speaker will be Dr. Charles H. Herty of New York, President of the Organic Manufacturers' Association. His address will deal with some applications of organic chemistry to industry.

Members coming from a distance and desiring accommodations for over Friday night, and members residing in and near Boston who are willing to receive guests for that time, should communicate with Mr. William W. Obear, High School, Somerville, Mass., who will look after the necessary arrangements. Those desiring tickets for the banquet should communicate with Mr. Shipley W. Ricker, 14 Brooks St., West Medford, Mass., who has the matter in charge.

University of Florida. The members of the chemistry staff have coöperated in the preparation of a series of twenty-one special articles of a "popular science" nature. These articles will be handled by the associated press of Florida and published in the 49 leading dailies of the state, the series extending through about twelve weeks. It is believed that the wide circulation of a series of articles of this nature will serve to encourage general reading along scientific lines and to promote an understanding of the fundamental importance of chemistry to industry, agriculture, and in general, to every phase and activity of life. A list of the titles, with authors, follows:

"The Human Chemical Laboratory," "The Story of an Ear of Corn," Prof. T. R. Leigh.

"Liquid Gold," "Food for Plant and Man," "The World of Little Things," Prof. A. P. Black.

"Growth of Chemistry at the U. of Fla.," "The History of Photography," Prof. F. H. Heath.

"Importance of Scientific Research to Industry," "The Story of a Chip of Wood," "Chemical Industries of Florida," Prof. W. H. Beisler.

"War Gases," "More Precious than Gold," "The Staff of Life," "Minutae," "It's Cold," Prof. V. T. Jackson.

"The Vitamines," "Water," Prof. H. G. Oddy.

"Chemistry and the Automobile," Mr. B. O. Otte.

"The Plant, a Chemical Laboratory," "Citrus Products," Mr. M. B. Matlack.

"We Do Need the Metric System," Mr. L. E. Dupont.

To find the truth is a matter of luck, the full value of which is only realized when we can prove that what we have found *is* true. Unfortunately, the certainty of our knowledge is at so low a level that all we can do is to follow along the lines of greatest probability.—J. J. BERZELIUS

Recent Books

Scientific Method in Education. WM. CLARK TROW, Ph.D., Associate Professor of Education, College of Education, University of Cincinnati. Houghton Mifflin Company, Boston, 1925. xi + 159 pp. 18 × 12 cm. $1.20 net.

This book is one of the well-known series of Riverside Educational Monographs, edited by President Henry Suzzallo.

The success of the scientific method in certain fields of investigation has lead to analysis and generalizations of the methods and these have been transferred to new fields. In the physical sciences the need for accurate data has long been recognized. Galileo, Copernicus, Kepler, Pasteur, Lavoisier are illustrations of those who have made their names immortal by their recognition of the need for facts and by their ability to collect, classify, and interpret them. Application of the scientific method has resulted in enormous developments in the biological sciences, medicine, psychology, and other fields. Its use is now demanded by leading educational workers.

The author of the book under review shows how the scientific method has evolved from primitive customs, and dependence upon religious and civil authority to a method of solving problems which is based upon interpretation of carefully collected data. Noteworthy analyses are made of the method of problem solving (Chapter III) and of the use of instruments of precision (Chapter IV) in the scientific procedure.

The multiplication of publications carrying quantitative and experimental studies in education shows clearly that the method of the scientist is finding rapid extension in the field of education. Those sciences which contribute most to the methods of studying educational problems are psychology, medicine, sociology, and economics. The last chapter defines the field of education and shows the need for and the possibilities of scientific experimentation within the field.

The monograph is written in excellent style and the theme which it develops is a very pertinent one for teachers of chemistry. Not infrequently outstanding scientists in one field are intolerant of and "unscientific" in their attitude toward the efforts of scientific workers in other fields. For such as these this little monograph is especially recommended.

S. R. POWERS

Certain Phases of the Administration of High-School Chemistry. WESTON WILLIAM CARPENTER, Ph.D. Bureau of Publications, Teachers College, Columbia University. Contributions to Education. No. 191, 1925. vii + 74 pp. Cloth, $1.50 net.

This monograph is the report of a study of high-school chemistry from the standpoint of high-school administration. It reports present practices in administration as these are revealed from data gathered from selected schools; it evaluates these practices; and it makes specific recommendations. The methods used are chiefly experimental and statistical.

Chapter II reports data gathered by questionnaire, from selected high schools. These relate to budgeting; requisitioning; the purchase, accounting, storage, and distribution of supplies; internal organization of the laboratory; laboratory space provisions; service; permanent equipment; and fire protection. The judgments of teachers and principals from a group of selected high schools are used to evaluate these practices.

The author's comparison of the results obtained from laboratory instruction following different methods is of particular interest to both teachers and administrators. He compared the results obtained from instruction by (1) the teacher demonstration method, (2) the individual pupil method, and (3) the method in which pupils work in groups of two. Results presented were obtained from experimental teaching and testing of results in twenty-three coöperating schools located in fourteen different states.

The final chapter reports a summation of recommendations for the departmental organization of science in secondary schools and it suggests the functions of this organization. The data upon which the statistical calculations are based, and the tests used in the experiment are printed in an appendix.

This book presents a well-defined problem, scientifically attacked, and clearly written. It is of value to all who are interested in science teaching and especially to those interested in the teaching and administration of high-school chemistry.

S. R. POWERS

Manual of Modern Chemistry (Leitfaden der Gegenwartschemie für Höhere Schulen). Part I, Inorganic. Prof. Dr. GUSTAV MEYER, Studienrat in the Reformrealgymnasium of Görlitz. Georg Thieme, Leipzig. First edition, 1925. xv + 185 pp. 45 figs. 13 × 19.5 cm.

This work is mainly a syllabus of the conventional laboratory experiments and theory

which are usually included in a course in introductory chemistry. Special attention is paid, however, to the advances of the past ten years in the subatomic field.

The usual order is followed: H, O, Acids, Bases, Water, S, Halogens, N, P, As, Sb, C, Si, and B, followed by the metals. The subtopics are: History, Occurrence, Preparation, Chemical and Physical Properties and Uses. Emphasis is placed upon the mineralogy of the important elements. In an appendix are tables of physical and chemical units, with conversion factors, and a table showing the important geologic periods with their characteristic sediments and plant and animal life.

While it could not serve alone as either a text or a laboratory manual, this little outline would make an excellent guide for a review of elementary inorganic chemistry.

R. A. BAKER

Chromium Improves Printing Plates. Better looking faces on our dollar bills as well as great saving to the government is achieved by a recently developed process of making electrolytic plates.

Experience at the U. S. Bureau of Engraving and Printing has shown that by the application of a thin layer, only $^1/_{5000}$ inch thick, of chromium to electrolytic plates used for printing paper currency, the life of the plates is increased to over twice that of case-hardened steel plates, and several times that of the nickel-faced electrolytic plates prior to the application of the chromium upon them. This increased service is due to the extreme hardness of chromium, the hardest metal known.

Chromium plating has long been known to be possible, but until recently it has not been commercially practicable. Considerable research was required to develop and adapt it for this purpose. This study was conducted by H. E. Haring of the Bureau of Standards.

According to Dr. William Blum of that Bureau, subsequent tests have shown that chromium plating is likewise valuable on other types of printing plates, especially those used for long editions, such as on soap wrappers, cartons, labels, etc. It will also probably be useful on dies and gauges where extreme hardness is required, and may obviate case hardening them.

Further researches such as are being conducted by the Bureau of Standards and by numerous commercial laboratories, will no doubt lead to still more extensive applications of chromium plating, including those where its resistance to tarnish as well as its hardness will be valuable.—*Science Service*

Why Flour Should Not Be Ground Too Fine. Flour ground too fine does not make good bread. While millers have always been aware of this fact no one seems ever to have determined upon what the poorer quality depended. Accordingly, Drs. C. L. Alsberg and E. P. Griffing, two biological chemists of the Food Research Institute at Stanford University, have undertaken a series of experiments to answer this question.

They have found that in over-ground flours the starch granules are injured so that carbon dioxide is given off at first instead of gradually throughout the whole baking process. This gives a bread that "rises" too fast at first and will not "come up" in the oven.

The gluten, also, of very finely ground flours is injured. Gluten is the substance in dough that gives it elasticity. Without this elastic property the dough is very difficult to knead. Any housewife knows that dough that is "crumbly" rather than "stretchy" will not make good bread.

The facts presented in the investigation show that the baking quality of flour is modified considerably by the mere mechanical processes to which it is subjected. Further studies are in progress at the Food Research Institute at Stanford to determine more fully the possibility of improvement of flour by its mechanical treatment.—*Science Service*

GO TO SUMMER SCHOOL!

$150.00 IN CASH PRIZES

$75.00 for subscribers in the United States East of the Mississippi
$75.00 for subscribers in the United States West of the Mississippi

Fifty dollars will be given toward the summer school expenses of that United States subscriber East of the Mississippi who sends us the best, not more than one hundred word advertisement on or before June 20, 1926, of the JOURNAL OF CHEMICAL EDUCATION. Fifteen dollars will be given for the second best, not more than one hundred word copy, and ten dollars for the third best, not more than one hundred word copy. Copy, in each case, must be accompanied by two paid new subscriptions ($4.00).

The above set of offers is made also for those living in the United States West of the Mississippi.

The awards will be made before July 1st and telegrams will be sent to the six winners and certified checks will be immediately forwarded to them.

The attached coupon must be used if you wish to enter the contest which is limited to paid subscribers within the United States.

JOURNAL OF CHEMICAL EDUCATION, 3
Kodak Park, Rochester, N. Y.

I wish to enter the not more than one hundred word prize advertisement contest for the JOURNAL OF CHEMICAL EDUCATION. My typewritten copy is enclosed in a *separate plain* envelope. Attached to *this* coupon is a check for $4.00 to cover the subscriptions of

Name.....

Street.....

City.....State.....

Name.....

Street.....

City.....State.....

Subscription sent by.....

Street.....

City.....

State.....

If I win first prize, I shall attend.....
(college of recognized standing)

.....summer school, so please telegraph me at.....

EVERY MONTH

Every month on the fifteenth, the JOURNAL OF CHEMICAL EDUCATION is issued. You get twelve copies a year. Most other educational journals reach you only nine or ten times during a year.

Discovery does not stop for summer. Education goes ever forward. So each month the JOURNAL OF CHEMICAL EDUCATION does its best to bring to its readers, information concerning progress in chemical science and educational methods.

Each month during the past two years has witnessed a steady increase in the volume of advertising taken by the various concerns. This steady growth has brought us to the point where the JOURNAL OF CHEMICAL EDUCATION now has the largest amount of advertising space of any comparable journal. This is a healthy sign. It means our readers appreciate the special copy written by our advertisers and buy of them.

In order that our readers may have their copies of the JOURNAL OF CHEMICAL EDUCATION wherever they may be located this coming summer, they are urged to send us the following coupon.

JOURNAL OF CHEMICAL EDUCATION,
Kodak Park, Rochester, N. Y.

Please change my address from.....

to.....until ..... issue

when it should be changed to.....

Signed.....